Chem & Met

NEXT MONTH

Not since April, 1932 have *Chem & Met* editors presented a thorough-going report on "Fuels for Chemical Process Industries." Tremendous developments since that time have greatly affected inter-fuel and inter-energy competition for our billion dollar heat and power bill. Next month we plan to present a study of the economic and technical trends that have an important bearing on the selection and use of fuels for steam and power generation. Chemical engineers responsible for both quality and cost of product in the process industries should welcome such a study.

McGRAW-HILL
PUBLISHING COMPANY, INC.

Published monthly, price 35 cents a copy. Address all communications about subscriptions to the Director of Circulation, 330 West 42nd St., New York, N. Y. Subscription rates—United States, Canada, Mexico, Central and South American countries, $3 a year, $4 for two years, $5 for three years. All other countries, $5 a year, $10 for three years. Great Britain and British Possessions 30 shillings for one year, 60 shillings for three years. Entered as second-class matter, Sept. 3, 1936, at Post Office at Albany, N. Y., U. S. A., under the act of March 3, 1879.

Price of this issue, one dollar per copy

A McGRAW-HILL PUBLICATION

CHEMICAL & METALLURGICAL ENGINEERING

ESTABLISHED 1902

CONTENTS

VOLUME 48 **FEBRUARY, 1941** NUMBER 2

S. D. KIRKPATRICK, *Editor* — M. A. WILLIAMSON, *Publisher*
JAMES A. LEE, *Managing Editor* — HENRY M. BATTERS, *Market Editor*
THEODORE R. OLIVE, *Associate Editor* — MELVIN E. CLARK, *Assistant Editor*
LESTER B. POPE, *Assistant Editor*

EDITORIAL REPRESENTATIVES

PAUL D. V. MANNING
68 Post St., San Francisco, Calif.
E. S. STATELER
520 N. Michigan Ave., Chicago, Ill.

R. S. McBRIDE
712 Jackson Pl., Washington, D. C.
EARLE MAULDIN
1011 Rhodes-Haverty Bldg., Atlanta, Ga.

CHEMICAL
& METALLURGICAL
ENGINEERING

ESTABLISHED 1902 S. D. KIRKPATRICK, *Editor*

FEBRUARY, 1941

ECONOMICS OF DEFENSE

ONCE EACH YEAR the editors of *Chem. & Met.* turn amateur economists and statisticians, bending every effort to compile and interpret the basic facts and figures bearing on the chemical and process industries. This year that problem is more complicated than usual. The national defense program introduces present and prospective demands for chemicals that distort or upset all normal calculations. But our economic problems —important as they seem to us—dwarf into insignificance when compared with those that this same program is placing on the American people as a whole. Some time, and soon, we have to begin thinking about the costs of defense and how we are going to pay the bills.

Dr. Harold G. Moulton of the Brookings Institution is one of the few real economists who can see through the maze of conflicting theories and practices. From his recent, continuing research, which is supported by the Falk Foundation of Pittsburgh, he has prepared a most interesting pamphlet entitled "Fundamental Economic Issues of National Defense." In it he asks four basic questions that are in the mind of everybody today. More important, he answers these questions in a way that should encourage better thinking on the part of all of us who are willing to face courageously the vital issues involved.

Question 1. Will the national defense program require extensive readjustments in the economic life of the nation? His conclusion, from an exhaustive study, is that during the next three fiscal years our economy can absorb this additional 20 billion dollars of non-productive enterprise without profound disorganization or reduction in living standards, *provided* we do certain important things. We must decide whether we are going to build additional plants in order that normal consumption of peace-time goods can go on expanding as usual, or whether, in the interest of maximum speed in the defense effort, we should curtail production and consumption of non-essentials. He favors the latter course. By converting our peacetime equipment to war-time use, he believes that we would minimize distortions in the productive system and at the same time build up a backlog of demand for consumption goods which should help tide us over the inevitable transition. But have we the courage to do it?

Question 2. Can the defense program be financed without an enormous increase in the public debt? The answer is "Yes, we must!" To meet these added costs out of current income will call for a tremendous effort. Higher taxes—approaching 25 percent of the national income—are only a part. Non-military public works must be cut to the bone and rigid economy practiced (for a change) in all governmental administration—federal, state and local. If we don't achieve a balanced budget during the coming period of high national income, the chances are we never will.

Question 3. Is it possible to carry through the defense program without a great inflation of commodity prices? Again the answer is "Yes"—but again the preventative is bitter medicine—sound, but unpopular fiscal and credit policies, wisely administered.

Question 4. Are we inevitably faced with a catastrophic economic collapse at the end of the war? Here the answer depends pretty much on what has already been noted above. If we can maintain financial equilibrium in the emergency, we shall be stronger than if we had merely added more billions to the national debt. If we can prevent price inflation, we need not worry about price deflation. If we can increase productive efficiency by making prompt use of new scientific discoveries and inventions and by installing more

efficient plants and equipment, then the United States should be able to produce more goods at lower prices than ever before.

So, it would seem, there is nothing in the defense program that is intrinsically impossible of economic achievement. But as the war effort expands, our problem becomes more and more complex. The efficiency with which we carry through the defense program and, in fact, the future of industry in America, will depend largely on the wisdom and courage with which these basic economic issues of national policy are attacked and settled.

TRUSTS AND ANTI-TRUSTS

A Prominent Official of the U. S. Department of Justice tells an amusing off-the-record story. A prosecution had been ordered against a group of manufacturers who had signed an agreement which was quite evidently in restraint of trade. One of the group called the government attorney aside and told him confidentially that he thought the whole matter should be dropped. "The truth is," he said, "that we did sign the agreement, but nobody ever lived up to it."

A prominent trade association executive raised this question: If it were the law of the land that every manufacturer in every industry should post all his prices and pool all information on production and shipments with that of all his competitors, would there be more or fewer violations of such a law than is the case with the Clayton Act today? The government official refused to conjecture a decision; but countered with the comment that the anti-trust laws have usually been applied to protect one division of industry against another rather than, as many are inclined to think, as a governmental persecution of business.

KNOW YOUR CUSTOMER BETTER

Few Chemical manufacturing industries have ever made as thorough a study of their customers' problems as has recently been completed by the manufacturers of fertilizer through the National Fertilizer Association. That study was conducted over a period of a year by means of direct interviews with 32,000 farmers who used fertilizer. Each interview was separately reported by a field man and the results have been analyzed and tabulated for complete and useful interpretation.

Chemical engineers will find the survey results of some interest to them because they show the influence of different crops, different areas, and different types of agriculture on the actual consumption of chemicals. It will be well worth while for any engineer or executive having to do with nitrogen, phosphorus, or potash chemicals to study the meanings underlying the opinions gathered directly from the ultimate farmer-users.

But the fertilizer makers also must study the results with the utmost care. Perhaps the most important conclusion indicated on first study relates to the customer group which needs education with respect to fertilizers. Apparently the general storekeeper who sells the fertilizer "over the counter" to the farmer himself is the man most in need of help and guidance. He is depended upon moreover by two out of three of the farmers interviewed. He apparently is more important than the county agent, the agricultural press, farm schools, advertising and all other influences put together. The fertilizer industry has probably known this vaguely, if not definitely. But now there is no excuse for ignoring these merchants who furnish the last and most potent word of advice regarding what the farmer buys. Even the chemical industries indirectly interested will also want to take account of this fact.

It is not amiss to suggest that a number of other industries that have great concern with the buying habits of ultimate consumers might well imitate for their own good the comprehensive, fact-finding job which has been done so well by the National Fertilizer Association.

SEEK SUBCONTRACTOR'S AID

Washington now gives greater emphasis to the need for speedup by subcontracting as well as by direct action. Not all chemical contracts will permit very much farming out of subsidiary parts of the job, but where this can be done, it should be—for several reasons.

Most big chemical companies will be delighted to subcontract any part of their job which they can get others to do for them efficiently. This will not only relieve them of excessive burdens, but also stabilize the smallar company operations. It will also prevent further expansion of capital investment on properties that may not have anything to do after the present emergency supplies have been produced. These three advantages combine in a very potent argument for this type of inter-company cooperation where it is feasible.

Some chemical engineers will doubtless suspect in this desire of Washington some element of "anti-bigness" effort. That may be a minor factor in some cases. But those in charge of defense production are very sincere in their feeling that the overload of defense manufacture has got to be spread more widely than at present or some of the larger units which are taking on tremendous new loads may break down under the strain. The idea is going to have a serious tryout, therefore, and far-seeing chemical executives will want to consider its significance for their own enterprises, even in cases where the practical advantage is not immediately evident.

Incidentally, if there are any small companies whose plants are not already busy, they can well make a few calls on their big neighbors who seem overbusy to see if there is not some way in which there can be useful subcontracting of jobs which the smaller firms may do for the overbusy larger enterprises.

EIGHTEENTH ANNUAL REVIEW AND STATISTICAL SECTION

Facts and Figures

OF AMERICAN CHEMICAL INDUSTRY

Wherein the editors of Chem & Met present a public accounting of the economic and technical status of the nation's most important industry. It is addressed to everybody because in some measure we are all stockholders, customers and/or employees in this billion dollar business that in 1940 topped all production records. This annual report of operations, trends and developments presents the facts and figures that are necessary for a better public understanding of American Chemical Industry and that should help us all to do a better job in 1941.

CHEMICAL AND METALLURGICAL ENGINEERING

February, 1941

THE 1940 ANNUAL

TO STOCK HOLDERS, CUSTOMERS AND EMPLOYEES OF

INTRODUCTION

FOR THE THIRD time in recent years, the editors of *Chem. & Met.* are privileged to report the "Facts and Figures of American Chemical Industry." In September, 1937, and again in September, 1939, were presented the basic statistics and factual information needed for a better understanding of this important and rapidly growing field. In the following pages another public accounting and interpretation has been combined with the detailed commodity reports and studies that have long featured the *Chem. & Met.* series of annual review and statistical numbers.—*The Editor.*

IN RETROSPECT

AMERICAN Chemical Industry has just completed the best year in its history. Its business has topped by about 15 percent the record output of $1,137,490,000 just reported by the U. S. Census of Manufactures for 1939. It has pushed production, not only for domestic peace-time products but also for those commodities needed by the national defense program. Exports have risen to the highest levels ever recorded. Research and development have not been seriously interrupted, although threatened lately by possible shortage of man-power. Chemical prices have been held to lower levels than those for most other commodities. Higher than average wages, shorter hours and improved working conditions have helped the industry to maintain its excellent relations with its employees. There have been few, if any, strikes of consequence in chemical plants. Public relations continue to be cordial. Financial strength is evidenced from the high return on invested capital and continued growth.

But all the picture cannot be painted in such rosy hues. Mounting taxes, to which the industry is particularly susceptible because of its relatively high earnings, threaten to stifle or discourage its continued growth by removing incentive to risk capital on new ventures. Chemical industry's vital relations to the national defense have led to tremendous demands being placed on it by a government that sometimes ill-conceals a desire for nationalization or at least for greatly increased federal control. Inflationary tendencies arising in other industries that supply raw materials have affected a few chemical prices, despite the industry's desire to maintain their long-time, downward trend. Personnel problems, particularly in the case of technically trained men, were beginning to pinch in a few places toward the end of 1940. But for the industry as a whole, 1940 adds up to a very good year—and an excellent start for what's ahead.

IN PROSPECT

AMERICAN Chemical Industry faces an uncertain future with the courage and confidence that have come from hard-earned experience. It has willingly accepted the challenge and responsibility for creating its share of America's "arsenals for democracy." It looks forward with some slight apprehension to the economic and social problems that must inevitably come when industry is demobilized again for peace-time pursuits. Yet there is considerable encouragement in the belief that if research and development are permitted to continue on their present scale, they will help make that transition easier by opening up new markets and opportunities for service. Broadly speaking, there is scarcely any conceivable limit to the growth of unhampered chemical enterprise in this country.

Immediately ahead in 1941 is the prospect of perhaps another 15 percent increase in activity, provided there is no interruption in the preparedness program. The first of the large government-owned chemical munitions plants will get into large-scale production by early summer. Others will require many more months for their construction and equipment, but chemical industry is already preparing to supply their raw material requirements.

Export demands, which in some cases have exceeded the industry's facilities for supplying them, are expected to continue at their recent high levels.

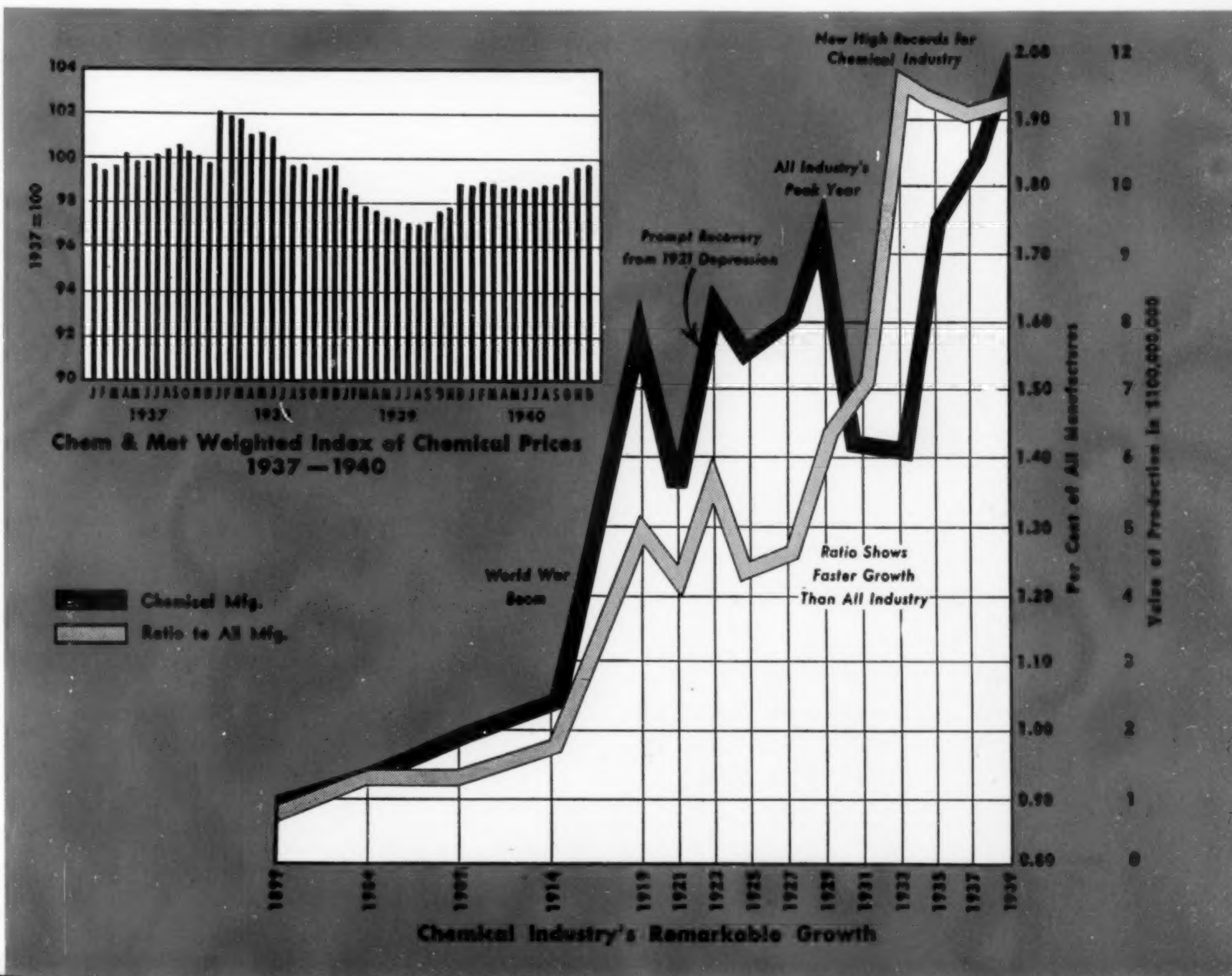
REPORT

AMERICAN CHEMICAL INDUSTRY

MANAGEMENT AND OPERATIONS

To send \$20,000,000 of chemicals abroad each month in 1941 would call for a considerable expansion of production capacity in a number of different lines. This emphasizes once again the likely shortages of chemical engineering equipment and construction facilities that may well develop during 1941 if present trends continue.

Prices and delivery are going to assume even greater significance this year. The present informal and voluntary system of priorities is certain to become more stringent as long as the war continues in Europe. Considerable power and authority have already been delegated to the new defense agencies in Washington, and as the need arises these powers will undoubtedly be exercised. This will mean that some divisions of chemical industry are going to be favored over less essential or non-essential classifications. The resulting problem cannot yet be clearly defined but it is well to begin to anticipate its nature and possible solutions.



Chemical Industry's Remarkable Growth

A COMBINED BALANCE sheet of the assets and liabilities of all the several hundred companies that comprise the American Chemical Industry, has never been compiled. Perhaps the nearest approach is that sponsored by the Securities and Exchange Commission in its annual "Survey of American Listed Corporations." In December 1940 it released a detailed report of 21 companies in the chemical and fertilizer industries, each of which had assets of over $10 millions. Fortunately, there is a reasonable similarity between this group and the American Chemical Industry as a whole.

It should be pointed out, however, that four of these companies are engaged in fertilizer manufacture—an industry that differs considerably from chemicals in its financial aspects. Also the inclusion of such large companies as duPont, Carbide and Allied introduces holdings in certain other industries that are chemical processing rather than manufacture, e.g., rayon, cellophane, ferro alloys, carbon and coal products.

The combined volume of business for these 21 enterprises amounted to $984 millions in 1939. Their combined operating profit of $179 millions was 18.2 percent of sales. Depreciation and depletion charges amounted to $62 millions or 6.3 percent of sales. Of the 21 companies, 20 reported operating profits and only one reported an operating loss.

Combined profit after all charges (including non-operating gains and losses, prior claims, interest and

COMBINED BALANCE SHEET AND PROFIT AND LOSS STATEMENT

ASSETS
Thousands of Dollars

ITEMS	AMOUNT	PERCENT OF TOTAL
Cash and Cash Items	269,052	15.0
Marketable Securities	51,657	2.9
Trade Receivables**	115,046	6.4
Inventories**	204,968	11.5
Other Current**	5,964	.3
Total Current Assets**	646,688	36.1
Investment in Affiliates**	32,192	1.8
Other Security Investments**	279,085	15.6
Other Non-Security Investments**	2,618	.1
Other Investments Not Segregated**	1,100	.1
Total Investments**	314,995	17.6
Treasury Stock	7,320	.4
Land, Buildings and Equipment**	741,852	41.4
Intangibles**	61,550	3.4
Deferred Charges**	9,733	.5
Other Assets**	10,186	.6
Total Assets**	1,792,325	100.0
Reserves Deducted Above:		
For Current Assets	9,554	
For Investments	820	
For Land, Buildings and Equipment	611,794	

*Following companies, each having assets over $10,000,000 were included in this study by W. P. A. for U. S. Securities and Exchange Commission: Air Reduction Co., Inc.; Allied Chem. and Dye Corp.; The American Ag. Chem. Co. (of Del.); Atlas Powder Co.; Columbian Carbon Co.; Commercial Solvents Corp.; The Davison Chem. Corp.; The Dow Chem. Co.; E. I. du Pont de Nemours and Co.; Hercules Powder Co.; Interchemical Corp.; International Ag. Corp.; Mathieson Alkali Works; Monsanto Chem. Co.; Pennsylvania Salt Mfg. Co.; Tennessee Corp.; Union Carbide and Carbon Corp.; United Carbon Co.; U. S. Industrial Alcohol Co.; Virginia-Carolina Chem. Corp.; and Westvaco Chlorine Products Corp.

**After reserves—unless registrant carried valuation reserves as liabilities.

LIABILITIES AND NET WORTH
Thousands of Dollars

ITEMS	AMOUNT	PERCENT OF TOTAL
Notes Payable	2,000	.1
Accounts Payable — Trade	35,624	2.0
Accrued Items	56,924	3.2
Other Current Liabilities	23,057	1.3
Total Current Liabilities	117,606	6.6
Bonds, Notes, and Mortgage Instalments Due in One Year	2,373	.1
Deferred Income	114	.A
Funded Debt	51,500	2.9
Non-Current Debt to Affiliates	0	.0
Other Long-Term Debt	3,183	.2
Total Long-Term Debt	54,683	3.1
Other Liabilities	34,022	1.9
Valuation Reserves—For Fixed Assets	0	.0
Valuation Reserves — Other	40,000	2.2
Other Reserves	39,403	2.2
Total Reserves	79,403	4.4
Minority Interest	4,410	.2
Preferred Stock	247,324	13.8
Common Stock	594,373	33.2
Total Stock	841,697	47.0
Capital Surplus	133,910	7.5
Earned Surplus	524,107	29.2
Total Surplus	658,017	36.7
Total Capital Stock and Surplus	1,499,714	83.7
Total Liabilities and Net Worth	1,792,325	100.0

A—Denotes less than 1/20 of 1 percent

income taxes) of $189 millions or 18.2 percent of sales was reported. Twenty of the 21 companies reported profits after all charges. Dividends paid during 1939 totaled $149 millions of which $11 millions were current cash dividends on preferred stock and $138 millions were cash dividends on common stock.

The combined balance sheet assets for these companies amounted to $1,792 millions on December 31, 1939 as compared with $1,708 millions on December 31, 1938. Cash and cash items rose from $213 millions to $269 millions and trade receivable rose from $86 millions to $115 millions during this period. Marketable securities declined from $67 millions to $52 millions and inventories were reduced from $206 to $205 millions. The net result of these changes was an increase in current assets from $579 millions at the end of 1938 to $647 millions at the end of 1939. Land, building and equipment increased in their net book value from $737 millions to $742 millions, while reserves set aside for land, buildings and equipment increased from $568 millions to $612 millions during the same period.

Current ratio for these companies on December 31, 1939 was 5.50:1. Net sales per dollar of inventory or "turnover of inventory" was 4.80:1. Return on invested capital at book value in the year ended December 31, 1939, based on the total net profit before prior claims, interest and income taxes, was 14.56 percent compared with 8.84 percent in 1938.

OF AMERICAN CHEMICAL INDUSTRY (as of December 31, 1939)*

PROFIT AND LOSS STATEMENT

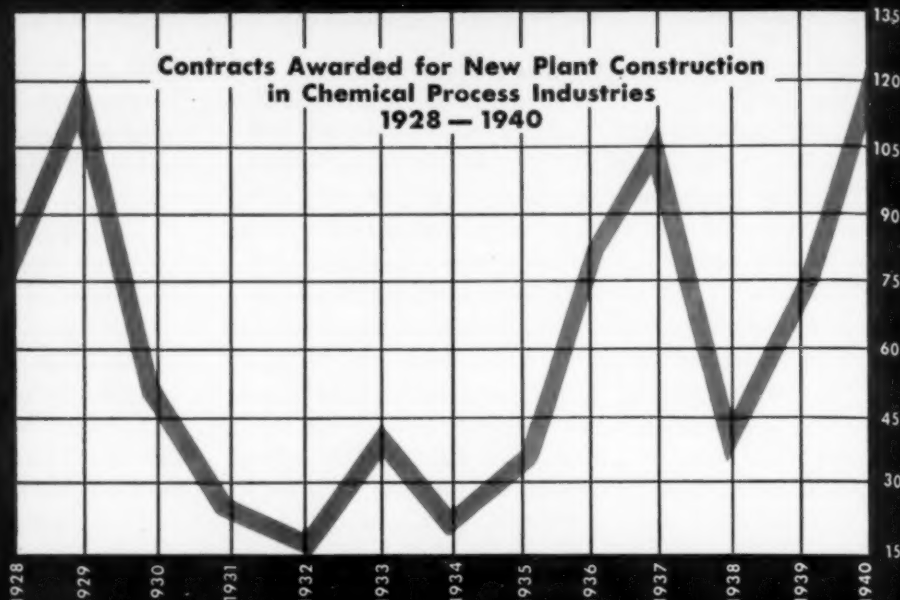
Thousands of Dollars

ITEMS	AMOUNT	PERCENT OF TOTAL
Sales	983,841	100.0
Cost of Sales	537,670	54.7
Gross Profit	446,171	45.3
Expenses Charged to Operations:		
Maintenance and Repairs	46,135	4.7
Depreciation, Depletion, etc.	62,005	6.3
Taxes (Other than Income)	26,145	2.7
Mgmt., Service Contract Fees	181	.A
Rents and Royalties	7,499	.7
Provision for Doubtful Accounts	1,751	.2
Selling, General, Administration	123,377	12.5
Total Charged to Operations	267,093	27.1
Net Profit from Operations	179,078	18.2
Other Income:		
Dividends	45,912	4.7
Interest	1,753	.2
Capital Gain	1,742	.2
Unclassified	4,405	.4
Total "Other" Income	53,812	5.5
Income Deductions:		
Capital Loss	12	.A
Unclassified	6,625	.7
Total Income Deductions	6,637	.7
Net Before Prior Claims, Interest and Income Taxes	226,253	23.0
Prior Claims	319	.A
Net Before Interest and Income Taxes	225,934	23.0
Interest Expense	3,125	.3
Net Before Income Taxes	222,809	22.7
Provision for Income Taxes	33,809	3.5
Net After All Charges	189,001	19.2

CLASSIFICATION OF SELECTED EXPENSES

Thousands of Dollars

ITEMS	AMOUNT	PERCENT OF TOTAL
Maintenance and Repairs:		
Charged to P & L as Costs	44,856	96.8
Charged Other Than as Costs	1,351	2.9
Charged to Other Accounts	114	.3
Total	46,321	100.0
Depreciation, Depletion, Amortization:		
Charged to P & L as Costs	55,386	88.7
Charged Other Than as Costs	6,878	11.0
Charged to Other Accounts	160	.3
Total	62,424	100.0
Taxes (Other Than Income, Excess Profits):		
Charged to P & L as Costs	18,072	68.4
Charged Other Than as Costs	8,161	30.9
Charged to Other Accounts	204	.7
Total	26,437	100.0
Management and Service Contract Fees:		
Charged to P & L as Costs	10	5.5
Charged Other Than as Costs	171	94.5
Charged to Other Accounts	0	.0
Total	181	100.0
Rents and Royalties:		
Charged to P & L as Costs	5,010	65.2
Charged Other Than as Costs	2,670	34.8
Charged to Other Accounts	0	.0
Total	7,680	100.0
Grand Total of Above Items:		
Charged to P & L as Costs	123,334	86.3
Charged Other Than as Costs	19,231	13.4
Charged to Other Accounts	478	.3
Total	143,043	100.0



Contracts for Private Industrial Building Construction *

(Value in thousands of dollars)	1929	1932	1937	1939	1940
Railroads	......	$1,108	$2,417	$1,447	$1,827
Automotive	$28,962	9,562	8,431	4,114	5,077
Public Utilities	151,033	22,800	70,765	94,822	121,155
Process Industries (a)	122,048	19,002	111,246	78,239	123,165
Food Industries (b)	32,138	14,385	36,248	23,049	28,292
Metal Refining and Rolling	48,929	745	111,426	22,340	66,390
Auto Factories	......	3,735	21,763	1,562	5,536
Aircraft Factories	14,818	418	4,312	11,037	137,656
Foundries	4,150	188	1,890	1,819	2,050
Machine and Machined Parts (c)	17,044	5,220	41,030	14,343	48,446
Textiles (excluding rayon)	9,706	2,047	5,017	3,714	1,931
Wood Industries	4,857	595	825	950	2,890
Miscellaneous Factories	110,311	12,646	61,511	24,744	49,065
Refrigeration and Cold Storage	3,327	618	417	800	585
Total	$547,318	$93,064	$477,298	$282,980	$594,064

(a) Includes Distilleries. (b) Includes Breweries and Wineries. (c) Includes Radio Plants.

* As Reported by McGraw-Hill Construction News Services

OPERATING REVIEW

PRODUCTION—Chemicals production in 1940, as measured by the new Federal Reserve Index, averaged 115 on the basis of 1935-39 = 100. This compared with 102 for 1939 and 96 for 1938. Assuming no interruption in the preparedness program now under way, it has been estimated that this index will average approximately 127 for 1941—an increase of 10 percent. However, it should be pointed out that this index, which is based on manhours worked in a variety of chemical and allied industries, may not always reflect accurately the trend in chemical manufacturing *per se*.

SALES—Chemicals valued at more than a billion and a quarter dollars were sold in 1940 to a wide range of markets, both here and abroad. In a sense, the industry continued to be its own customer because a large proportion of chemical production is used for further processing in the chemical process industries. More than $220,000,000 of chemicals and related products were exported last year. Canada was our best customer, United Kingdom a close second. Together they accounted for more than a third of all chemical exports.

Among domestic industries, the fertilizer manufacturers are the largest *volume* consumers of chemicals. Pulp and paper are second, followed closely by glass and petroleum refining. From the standpoint of *value* of consumption, textile dyeing and finishing is probably our No. 1 chemical customer, while plastics, synthetic fibers, resins and lacquers are in the close running. Food processing is assuming greater importance as a chemical market. As natural products are gradually being displaced by synthetic materials, many of the older industries take on new significance as outlets for chemicals.

PRICES—Chemical prices, once they collapsed from the boom of 1919-20, have never since become inflated. It is significant that of all industrial raw materials, semi-manufactured and manufactured goods, chemicals alone are quoted below their 1913-14 levels. "Better goods at lower prices" is gospel that is practiced as well as preached. Over a period of years, chemical prices have trended steadily downward as voluntary reductions are made to open up new sales possibilities.

During 1940 there were fewer reductions than usual and to a certain extent these were off-set by slight increases necessitated by the rising costs of certain metals, ores and similar raw materials, over which the industry has no control. The *Chem. & Met.* Weighted Index of Chemical Prices, which stood at 98.72 in January 1940, closed the year at 99.64 and further advanced to an even 100.00 for January, 1941.

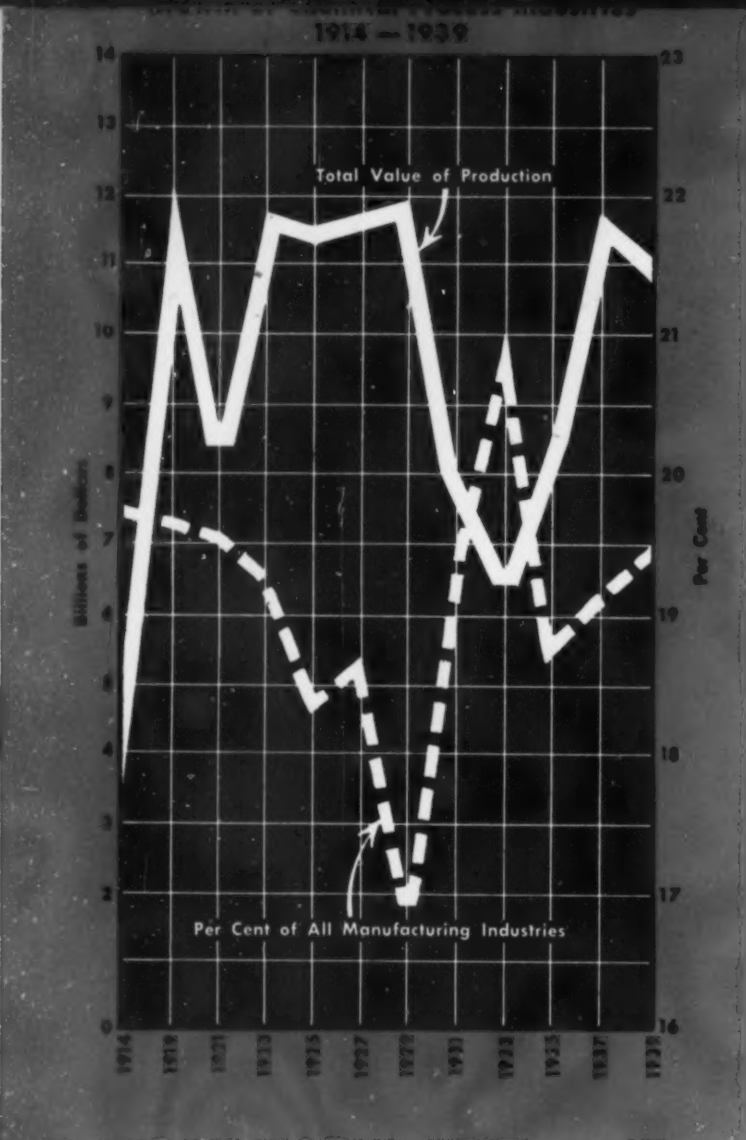
RESEARCH AND DEVELOPMENT—American Chemical Industry not only is the largest spender for research, but there is evidence to show that it gets a most profitable return on its investment. New markets are developed as well as new products and processes that become the bases of entirely new industries. Continued research is the secret of chemical industry's phenomenal growth.

Approximately a fifth of all that is spent on research in the United States goes into the laboratories and semi-works of chemical industry. Of 181 companies in all industries recently studied by the National Association of Manufacturers' Advisory Committee on Scientific Research, the highest research expenditures are found in chemical industries. The median figure was 4.0 percent of gross sales income spent for research by 28 companies making chemical and allied products. The ratios were highest in some of the smaller companies where as much as 10 percent or more of gross sales income went for research. All this compares with average expenditures of only about 0.2 percent on the part of American industry as a whole.

NEW CONSTRUCTION—The all-time records set for new plant construction in 1940 call for some explanation. On the opposite page it will be noted that *private* industrial building construction in the process industries amounted to $123,165,000 in 1940—more than a fifth of the U.S. total. In addition, contracts of $22,611,000 were let in Canada to bring the combined total to $145,775,000. The South continues to lead the country in chemical plant construction. Following in order are: "West of the Mississippi," the Middle Atlantic States, the Middle West, the Far West and New England.

But these expenditures for private industrial construction are only about a third of what Uncle Sam is spending for chemical munition plants. The list of the 20 plants contracted for up to January 10, 1941 totaled $335,000,000 and there were one smokeless powder and two bag-loading plants for which funds had not yet been alloted. Only a fraction of this money was actually spent during 1940 but it is expected that the program will be well advanced toward completion by the end of 1941 or during the first half of 1942.

CONCLUSION—Busy times are ahead for American Chemical Industry. The last few months of 1940 gave but a sample of the task to be accomplished as the defense burden and aid for Britain were being piled on top of abnormally high domestic business. It is to be hoped that in these trying times American Chemical Industry can maintain the record it has shown for sound financial structure, progressive management, efficient technology, intelligent research, fair prices, favorable labor conditions and cordial public relations.



REPORT OF PRODUCTION DEPARTMENT

WITH BUT 8.4 percent of the nation's plants, 12.4 percent of its industrial wage earners and 14.2 percent of its salaried employees, the American chemical process industries produced 19.5 percent of the total value of all manufactures in the United States in 1939. The new biennial Census for that year gives us the basis for these and many other interesting comparisons with the peak year of 1937.

The chemical process industries, i.e., those in which production is dependent upon chemical or chemical engineering processes, more nearly "held their own" than did all of American industry. The decline from 1937 was barely 5 percent as compared with 6.4 for the value of products of all manufactures. It is significant, however, that six of the sixteen industries showed important gains over their previous peaks. Chemicals, i.e., the chemical manufacturing industries that produce acids and alkalis, heavy and fine chemicals, coal-tar products,[1] etc., advanced 1.5 percent; drugs, medicines and cosmetics were up 5.3 percent; non-military explosives and fireworks, 4.2 percent; lime and cement, 5.5 percent; rubber goods, 2.2 percent and soap and cleaning compounds, 3.7 percent.

[1] For difference between "chemical manufacturing industries" and "chemical process industries" see basic data tabulated on p. 542, "Facts and Figures of American Chemical Industry, II," *Chem. & Met.* Sept. 1937.

WHAT THE NEW CENSUS OF MANUFACTURERS SHOWS FOR THE CHEMICAL PROCESS

	No. of Establishments			No. of Salaried Employees [1]			Total Salaries — $1,000 [1]		
	1939	1937	1935	1939	1937	1935	1939	1937	1935
Chemicals	2,766	2,780	2,468	20,100	22,518	21,412	$53,032	$54,065	$50,863
Coke Oven Products	112	94	88	2,161	2,111	1,743	5,772	5,695	4,138
Drugs, Medicines, Cosmetics	1,633	1,512	1,614	9,252	12,851	12,816	27,096	29,532	20,889
Explosives and Fireworks	139	131	126	990	1,052	985	2,779	2,814	2,562
Fertilizers	764	743	670	2,666	3,349	3,223	5,251	6,370	6,081
Glass and Ceramics	1,550	1,510	1,307	12,565	13,315	10,967	17,285	29,900	23,852
Leather Tanned	446	402	384	3,714	3,740	3,946	11,214	10,737	10,957
Lime and Cement	429	361	342	3,706	3,479	3,410	9,455	8,235	8,125
Oil and Fats	1,261	1,115	1,040	6,422	6,795	5,464	14,865	15,147	11,637
Paints and Varnishes	1,255	1,124	1,082	8,745	11,995	10,914	24,931	28,522	24,472
Paper and Pulp	832	841	779	14,697	13,879	13,760	38,860	36,971	35,025
Petroleum Products	485	365	395	14,746	15,268	14,709	38,195	36,303	33,841
Rayon and Film	30	33	32	5,266	5,172	3,607	12,293	11,579	7,482
Rubber Goods	595	478	466	18,636	20,147	16,845	44,437	45,022	59,868
Soap and Cleaning Compounds	901	742	800	5,611	5,800	5,432	13,998	12,998	12,601
Other Products	2,234	2,608	2,166	19,814	28,912	21,370	48,847	69,898	48,651
Total	15,441	14,848	13,759	149,091	160,383	150,603	368,310	403,878	370,044
Total for all industry [2]	184,244	166,794	167,916	1,049,468	1,217,171	1,058,501	2,542,040	2,716,866	2,253,425
Percent in Chemical Process Industries	8.4	8.9	8.2	14.2	13.2	14.2	14.5	14.8	16.4

[1] 1939 figures not strictly comparable due to change in Census procedure. See text for explanation.
[2] 1937 and 1939 returns do not include "Manufactured Gas" or "Railroad Repair Shops" as manufacturing industries. 1935 figures have been lowered accordingly.

PRODUCTION TRENDS

IN THE CHEMICAL PROCESS INDUSTRIES

These comparisons in gross values of production do not take into consideration the important fact that most commodity prices in 1939 were lower than in 1937. In the case of chemicals, for example, the *Chem. & Met.* weighted index of chemical prices recorded a decline of more than 3 percent. Hence the net gain in volume of production in this bracket was probably in the neighborhood of 5 percent. Prices of drugs and pharmaceuticals dropped 8.4 percent. Wholesale prices of all commodities (except farm products and foods) declined, according to the U. S. Bureau of Labor's index, from a 1937 average of 85.3 to 81.3 for 1939 (basis 1926 = 100). There can be little doubt, therefore, that as far as the actual volume of production is concerned, the chemical process industries more than held their own in 1939. Although official statistics are still lacking for 1940 there is good evidence that production trends have subsequently continued upward.

The highly stable character of the chemical process industries as a whole is evident from the accompanying chart and tabulations. Although the totals do not reflect the same spectacular rate of growth reported for the strictly chemical or chemical manufacturing industry, the ratios of the chemical process industries to all manufacturing industries have varied less than 4 percent during the past forty years. It is significant that this ratio has been highest in periods of depression (21.0 percent in 1933) and lowest in years of inflated business activities (17.0 percent in 1929). That the ratio increased from 19.2 percent in 1937 to 19.5 percent in 1939, is in keeping with this generalization.

It is also important to point out that in the current Census compilation the figures for both salaried employees and wage earners are not entirely comparable with those for preceding years. The 1939 schedules set up a distinction between personnel actually engaged in manufacturing and those engaged in distribution, construction and certain other activities carried on at the manufacturing plants. The preliminary figures for 1939, on which the accompanying table is based, include only salaried employees and wage earners actually engaged in manufacturing but it is announced that when the final report is issued by the Census Bureau, it will cover the distribution, construction and other groups that have been reported in previous years. For this reason, too much significance should not be attached to the slight decline in 1939 shown here for both personnel and payroll. However, the ratios of chemical process industries to all industries have not been affected by this change in Census procedure.

INDUSTRIES AND ALL MANUFACTURING INDUSTRIES, 1935, 1937 AND 1939

No. of Wage Earners[1]			Total Wages — $1,000[1]			Cost of Materials, Containers, Fuel and Power — $1,000			Value of Products — $1,000		
1939	1937	1935	1939	1937	1935	1939	1937	1935	1939	1937	1935
83,130	93,714	85,527	$120,699	$131,409	$99,026	$509,378	$539,223	$410,813	$1,137,490	$1,120,607	$862,707
21,693	20,603	16,694	32,481	33,103	21,575	261,217	259,919	177,147	346,978	357,469	238,704
32,749	34,952	31,790	33,542	36,227	30,565	173,782	157,489	128,463	512,451	486,190	411,263
8,400	8,691	6,158	11,952	12,127	6,956	28,713	29,661	19,627	75,681	72,710	47,172
18,744	20,893	17,473	13,678	15,364	10,967	128,630	130,081	93,382	185,684	195,759	140,386
129,946	142,678	111,948	147,132	165,206	106,245	180,669	204,624	148,254	554,006	581,152	395,776
47,252	50,687	50,877	56,783	61,288	55,683	228,774	282,176	199,411	346,438	395,022	308,345
33,259	36,177	28,195	40,657	43,680	26,956	82,236	83,266	51,864	229,582	218,223	143,730
33,680	34,888	24,229	31,542	31,070	18,295	491,204	504,303	260,014	630,863	745,520	374,707
28,173	31,664	27,686	39,816	42,751	32,187	288,959	312,085	231,983	518,847	538,461	417,000
137,445	137,803	126,971	175,688	175,650	133,602	676,997	721,101	525,280	1,159,867	1,205,132	879,002
72,840	83,182	77,402	128,214	140,415	109,611	1,933,264	2,064,307	1,478,225	2,461,127	2,546,746	1,838,622
48,332	55,098	50,550	60,030	65,291	50,693	78,460	80,616	64,506	247,066	254,697	185,160
120,740	129,818	114,681	161,410	171,305	133,602	496,174	514,260	368,582	902,329	883,033	677,659
18,752	18,885	18,233	24,477	24,497	18,971	198,673	216,802	165,184	392,401	378,346	299,491
145,906	230,164	168,364	153,280	249,416	152,908	845,814	1,031,678	822,276	1,401,588	1,703,827	1,280,545
981,041	1,129,887	956,778	1,231,381	1,398,790	1,007,842	6,602,944	7,221,591	5,145,081	11,102,398	11,682,894	8,500,278
7,877,242	8,569,231	7,203,794	9,089,928	10,112,883	7,311,329	32,118,242	35,339,333	26,441,145	56,828,807	60,712,872	44,993,699
12.4	13.2	13.3	13.5	13.8	13.8	20.5	20.4	19.5	19.5	19.2	18.9

REPORT OF RAW MATERIALS DEPARTMENT

CONSUMPTION

IN THE CHEMICAL PROCESS

REPORTS regarding enlarged activities at chemical plants last year are brought into closer perspective by reference to the principal manufacturing industries which consume the greater part of chemical output. It is true that the chemical industry is its own best customer but the further fabrication and conversion of raw materials within the industry is proscribed in extent by the ability of outside consumers to absorb the final products of the chemical manufacturers. Hence developments within the consuming trades offer the best possible indication for what may be expected in the way of future chemical production. Even the existence of new chemical products is contingent upon satisfactory outlets if they are to assume commercial importance. For the time being, export trade is running above the usual quotas and therefore is a factor to be considered.

An examination of the index for consumption of chemicals reveals that manufacturing requirements last year were larger than ever before, surpassing the previous peak year of 1937 by approximately 8 percent. This outcome may be ascribed to the upsurge in business which was fairly general and which created a greater demand for almost all kinds of manufactured products. The rate of progress reported for the various consuming trades was not uniform and it is evident that the general status of business was modified in some cases by the existence of conditions peculiar to the respective lines of manufacture.

Some interesting conclusions may be drawn from an inspection of the annual rates of fluctuation as shown for the various consuming branches over a long-term period. The newer industries as typified by rayon, show an almost unbroken annual increment. Barring an industrial upheaval, it is possible to project this rate of annual growth into terms of future accomplishment, the trend being upward until such time as the point of saturation has been reached. In like manner the course of plastics becomes clear, as new types come on the market and new adaptations are found for all types.

While the older manufacturing lines are forced to keep production schedules more or less in conformity with the markets for their finished products there are intra-industry developments which carry considerable chemical significance. This may be illustrated by citing the greater diversity of products turned out by glass plants where production of building blocks and fibers is now adding considerably to their requirements of chemicals and other raw materials.

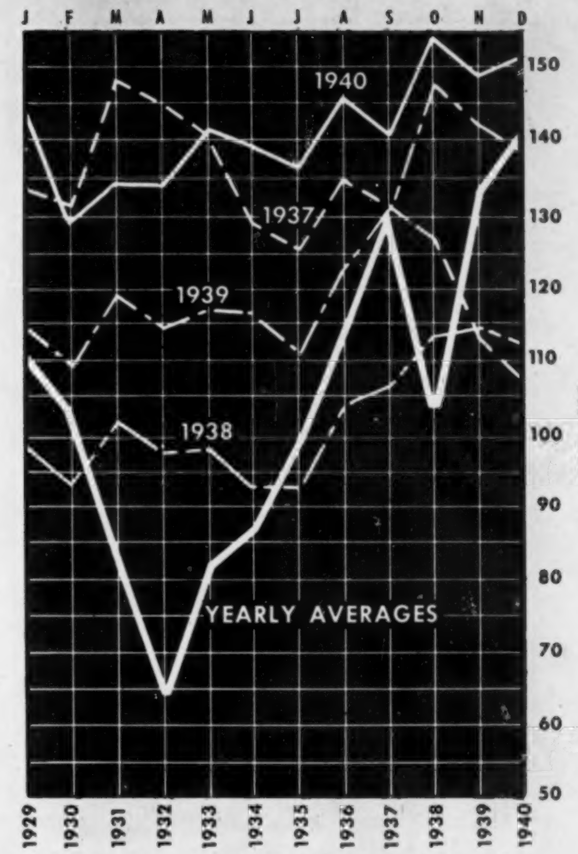
The pulp and paper trade has been featured in the last few years by the erection of new sulphate pulp mills. These additions were not immediately reflected in the market for chemicals because a large part of the salt cake used in pulp manufacture came from abroad. With the elimination of the most powerful foreign competitor, a good part of loss in imports has been made up by larger home production. So long as present world conditions continue, this situation should remain unchanged but there

CHEM & MET'S WEIGHTED INDEX FOR CONSUMPTION OF CHEMICALS BASED ON

Industry	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939
Fertilizer	24.95	26.40	18.53	11.64	17.78	18.91	19.47	22.57	28.93	23.72	25.13
Pulp and paper	12.07	11.46	10.71	9.34	10.80	11.15	12.39	14.31	15.96	13.70	16.52
Glass	10.60	9.31	8.00	6.03	7.71	8.21	10.58	12.45	13.61	9.00	12.51
Petroleum	10.86	10.11	9.77	8.93	9.37	9.74	10.51	11.61	12.87	12.68	13.45
Paint, varnish, and lacquer	12.84	10.40	8.62	5.96	6.80	8.54	10.35	10.77	11.33	9.47	10.66
Iron and steel	9.13	7.53	5.56	3.10	4.46	5.43	7.20	8.00	9.21	5.87	8.21
Rayon	2.92	3.07	3.65	3.29	5.23	5.09	6.29	7.01	7.97	5.82	9.08
Textiles	7.03	5.38	5.62	5.13	6.40	5.52	6.11	7.44	7.62	6.14	7.89
Coal products	8.55	7.32	5.23	3.58	4.22	4.88	5.74	7.46	9.66	5.37	7.17
Leather	3.75	3.32	3.25	3.11	3.55	3.65	3.95	4.08	4.10	3.35	4.16
Explosives	5.89	5.17	3.97	2.76	3.04	3.74	3.62	4.60	4.71	3.89	4.53
Rubber	2.53	2.02	1.58	1.57	1.86	2.10	2.17	2.58	2.56	1.86	2.79
Plastics	.79	.78	.82	.64	.78	1.09	1.62	1.97	2.28	1.30	2.05
	111.91	102.29	85.31	65.08	82.00	88.05	100.00	114.85	130.81	102.17	124.15

TRENDS

INDUSTRIES



Chem & Met Weighted Index of Chemical Consumption

is some uncertainty about what will happen when former suppliers are again in a position to renew offers. However, of late there has been a trend toward increasing the amount of sulphate pulp which is bleached and this in turn has widened demand for bleaching compounds and this appears to be a permanent development. Curtailment of sulphite pulp imports, likewise has been responsible for expending domestic capacities and consumption of sulphur in that field reached an all-time high last year.

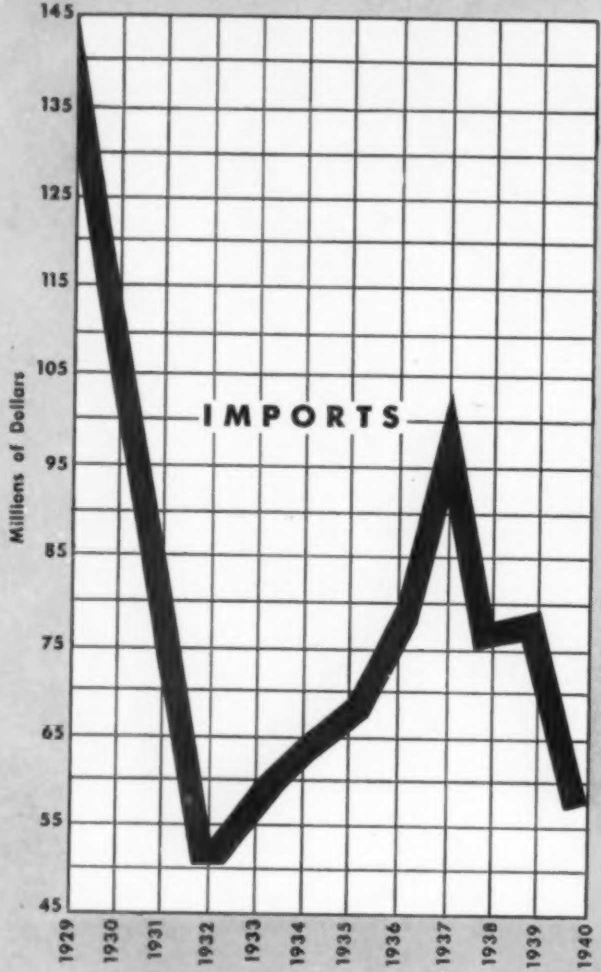
In the textile trade, the ordinary cycles may be disregarded as they are dependent upon the existence of ordinary conditions and buying on the part of the Government combined with the rise in public buying power will dominate the situation for some months ahead. Estimates for cotton consumption indicate a record year and woolen mills are expected to better their showing of last year while there seems to be no doubt of further gains in rayon consumption in view of increasing diversity in its use.

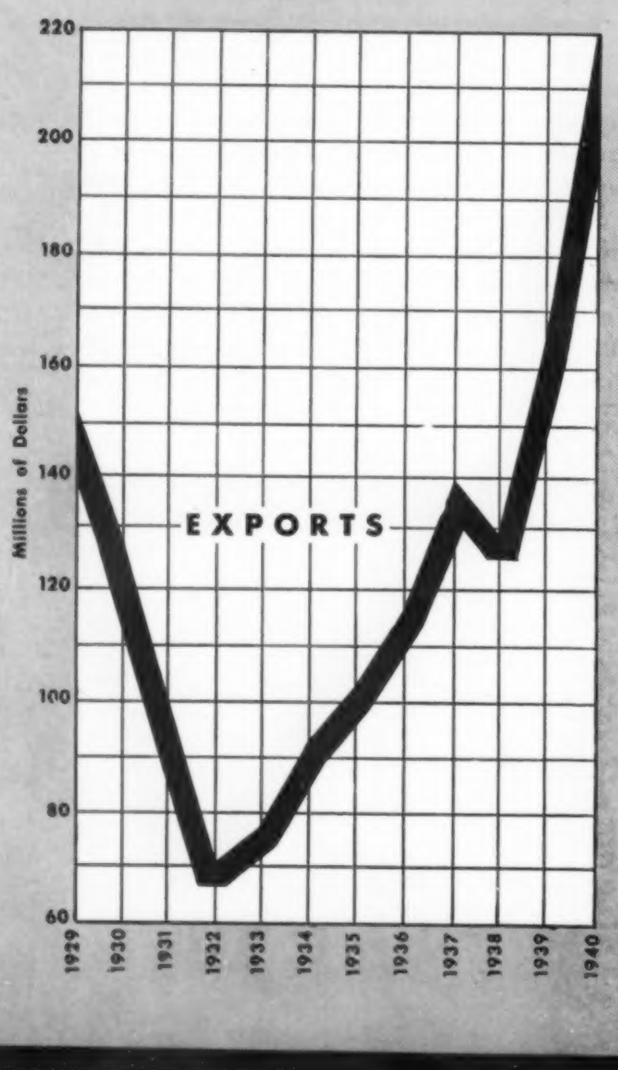
Steel mills entered the year at near-capacity levels and the trend has since been upward. It was reported that some bottlenecks in pickling operations were encountered in the latter part of last year but no doubt expansion programs will correct this situation and acid requirements in that field promise to establish a record in the present year.

Any analysis of trends based on past performances, however, must be viewed in conjunction with the possibilities arising from the defense and the aid to Britain program so far as the present year is concerned. Military preparations with new power plants coming into operations will create a demand for chemicals which will reach large totals. Other government activities will be responsible for direct buying of chemicals as such. In addition, the multitude of products for which chemicals are essential raw materials, will be consumed in larger volume and this will lead back to activities in the regular channels of manufacture with a continuance of the rising line which marked last year's operations.

PRODUCTIVE ACTIVITIES IN PRINCIPAL CONSUMING INDUSTRIES, 1929-1940

1940												
Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
34.23	28.14	27.70	26.83	27.27	26.05	26.10	27.88	26.10	31.49	30.96	31.80	Fertilizer
19.10	17.83	18.79	19.10	22.64	21.60	19.50	20.45	19.92	20.80	20.60	21.00	Pulp and paper
12.96	11.94	13.20	12.54	12.76	11.94	12.34	14.08	13.68	14.73	13.90	13.83	Glass
14.01	13.26	14.36	13.82	14.50	14.22	14.13	14.16	14.08	14.36	13.75	14.27	Petroleum
9.31	8.60	10.27	12.22	14.11	12.25	11.05	11.83	11.50	12.72	10.37	9.20	Paint, varnish, and lacquer
10.97	8.73	8.57	7.83	7.92	10.86	11.26	11.87	11.50	12.39	12.25	12.30	Iron and steel
10.98	10.46	10.70	11.04	11.41	11.23	11.24	11.89	11.10	12.38	12.16	12.67	Rayon
9.20	8.33	7.82	7.81	7.92	7.13	7.77	8.41	8.15	10.07	9.57	9.86	Textiles
9.01	8.04	8.36	8.14	8.61	8.73	9.06	9.29	9.32	9.42	9.37	9.60	Coal products
4.10	3.72	3.70	3.59	3.51	3.59	3.94	4.27	4.23	4.27	4.22	4.15	Leather
5.06	4.53	4.41	4.55	5.03	4.80	4.87	5.21	5.43	5.49	5.03	4.88	Explosives
3.32	3.07	3.09	2.96	3.03	2.82	2.71	2.92	2.90	3.30	3.20	3.32	Rubber
2.60	2.57	2.64	2.56	2.64	2.64	2.60	2.70	2.93	3.16	3.00	3.17	Plastics
144.85	129.22	133.61	132.99	141.35	137.86	136.57	144.96	140.84	154.58	148.38	150.05	





IMPORTS

OF CHEMICALS AND

BEGINNING WITH September 1939 and going through last year, foreign trade in chemicals and related products has been thrown out of normal balance and various adjustments have been forced in order to comply with demands created by the new international alignment. Elimination of some foreign markets and partial closing of others, had the dual effect of cutting off sources of supply for importing countries and of contracting the customary markets for exporters. How such adjustments were carried out in this country is best summarized by the official records for our import and export trade last year.

With totals for December estimated from preliminary figures, our exports of chemicals and related products in 1940 reached a value of $220,000,000 which is considerably higher than the total reported for any previous year. Compared with the preceding year this represents a gain of close to 35 percent and compared with 1938—when war-time influences were not felt—a gain of more than 46 percent. These totals are based on the groupings as set forth in Group 8 in the Department of Commerce summary of foreign commerce, and taking Census Bureau data for 1939 as representing total value for production in these groups, its is found that exports in that year were less than 6 percent of production. Comparable production data for 1940 are not available but allowing a 10 percent over-all gain would mean that the export ratio had risen above 7 percent.

The increase in outward shipments of chemicals while distributed over world-wide areas, does not appear to have materially changed the relative importance of our export outlets. Normally, the United Kingdom and Canada have been our largest customers and shipments to those countries last year were in keeping with the rise in total shipments although export business with South America and other countries also contributed much to the larger total.

Referring to the individual groups, it is found that there was a slight drop in export values for paints and pigments and a decrease of more than 17 percent in shipments of soap and toilet preparations. With these exceptions, the trend was decidely upward. The highest rate of gain was re-

AND EXPORTS

RELATED PRODUCTS

corded for explosives with a rise of more than 350 percent over the 1939 totals. The items for which material increases were noted include smokeless powder, and other explosives, except dynamite which showed very little change from the preceding year. Safety fuses and blasting caps also shared in the larger trade.

Coal-tar chemicals figured prominently in our export trade with a gain of close to 50 percent over the 1939 figures. Colors and dyes continued to hold the ranking place in this group with outward shipments more than doubling in value and almost doubling in volume. A still higher relative gain was reported for intermediates. Data for exports of toluol were not included separately in the 1939 compilation but exceeded 55,000,000 lb. last year. In the early part of the period large amounts were sent to France and Sweden but later on, the United Kingdom was the point of destination for the greater part of shipments and late in the year Canada became important as a buyer. Japan appeared regulary in the monthly total and one shipment of approximately 1,000,000 lb. was credited to Turkey.

Industrial chemicals improved their position to about the same extent as that reported for coal-tars, although sodium compounds, which make up a good part of the total made a poor showing from a volume standpoint. The general increase was due to increased foreign buying of a widely assorted range of chemicals rather than to unusually large buying of any of the individual items.

The movement of chemicals in import trade was in marked contrast with the results reported for exports. Some pickup was noted in December but the figures for the year indicated a drop in value of about 12 percent from the 1939 level. The poorer showing was general inasmuch as it extended throughout the different subdivisions and being more pronounced in the case of coal-tar products. In fact the change in the import situation may be described by applying the term general to all the individual selections as each contributed to the decline and it is difficult to pick out any single item which held up to the 1939 figures.

As soon as the import set-up became involved, the foreign chemicals which are important in our industrial programs and which could not easily be replaced immediately came into bold relief. They included salt cake, coal-tar intermediates, chlorate and sulphate of potash. To a lesser extent these were the products which were in limited supply last year although a large part of the defiiciency had been taken care of by increasing home production, in some cases this representing entirely new outputs for this country.

EXPORT TRADE IN CHEMICALS BY GROUPS—1929-1940

Value in $1,000	1940 11 Months	1939	1938	1937	1936	1935	1934	1933	1932	1931	1930	1929
Coal-Tar Products	$26,284	$14,612	$9,890	$14,878	$13,776	$13,959	$13,264	$12,423	$8,752	$10,347	$17,556	$18,059
Medicinal and Pharmaceutical Preparations	26,707	22,317	17,079	17,979	14,393	12,239	10,973	9,816	10,027	15,104	17,801	21,282
Chemical Specialties	35,386	36,041	28,953	27,526	20,456	12,868	11,612	10,663	9,949	13,754	15,589	14,457
Industrial Chemicals	48,834	36,514	25,173	27,505	22,046	23,627	21,683	16,802	14,954	19,774	23,015	28,194
Pigments, Paints, and Varnishes	20,778	22,761	18,655	21,544	17,788	16,345	14,214	11,834	10,366	15,127	21,689	29,119
Fertilizers and Fertilizer Materials	18,379	17,141	16,531	16,954	17,750	14,809	12,543	8,269	8,653	13,011	15,284	20,444
Explosives, Fuses, etc	19,122	4,999	3,666	3,863	2,618	2,439	2,149	1,527	1,282	1 734	2,950	4,549
Soap and Toilet Preparations	7,890	10,311	8,963	9,164	8,075	7,028	6,180	5,436	6,422	11,283	13,970	16,059
Total	$203,380	$164,656	$128,910	$139,448	$116,902	$103,493	$92,618	$76,760	$70,405	$100,134	$127,854	$152,063

IMPORT TRADE IN CHEMICALS, BY GROUPS—1929-1940

	1940 11 months	1939	1938	1937	1936	1935	1934	1933	1932	1931	1930	1929
Coal-Tar Products	$8,549	$18,942	$15,970	$18,353	$15,212	$13,557	$11,847	$9,997	$9,157	$11,162	$16,273	$22,823
Medicinal and Pharmaceutical Preparations	4,370	5,507	4,328	4,894	4,890	4,127	4,234	3,605	2,530	3,973	4,947	6,422
Industrial Chemicals	11,647	17,632	16,794	26,447	20,960	16,145	17,469	17,236	14,440	17,198	23,299	30,644
Pigments, Paints, and Varnishes	942	1,519	1,368	2,179	1,971	2,109	1,694	2,033	1 446	2,016	2,612	3,821
Fertilizers and Fertilizer Materials	25,830	32,455	36,496	46,704	33,394	28,560	26,029	24,573	17,858	44,732	50,150	72,339
Explosives	418	409	655	864	738	827	588	244	338	520	910	959
Soap and Toilet Preparations	2,053	3,015	2,409	5,131	2,811	3,387	3,203	2,184	2,005	3,027	4,719	6,940
Total	$53,809	$79,479	$78,020	$102,571	$79,976	$68,716	$65,058	$59,874	$47,776	$82,626	$111,904	$143,940

COMMODITY REVIEWS

MINERAL ACIDS AND SULPHUR

Sulphuric acid reached new heights in 1940, with production estimated at 9,185,000 tons and consumption at nearly the same level. Sulphur production approximated the level of 1937, while uses of sulphur appear to have been more extensive than before. Although detailed estimates of nitric acid are not available, it is believed that production was considerably higher than average. Defense requirements will multiply present capacity several fold.

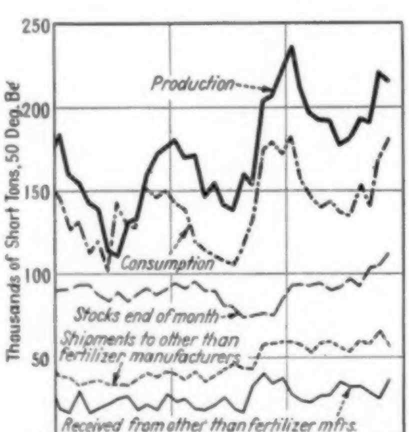
BOTH PRODUCTION and consumption of sulphuric acid exceeded previous records in 1940, with gains in practically all consuming fields in comparison with the best previous year, 1937. Our estimates show a total production in 1940 of approximately 9,185,000 short tons on the 50 deg. Bé. basis, compared with our earlier estimates of roughly 9,000,000 tons in 1937, 6,585,000 tons in 1938 and 8,209,000 tons in 1939. As in several previous years, it has proved impossible to bring our production figures down as low as those shown by the Census. Furthermore, except in 1938, these production estimates in recent years have tended to be slightly above apparent consumption, as shown in accompanying table.

As our distribution tabulation shows, all principal consuming industries required more sulphuric acid in 1940 than in 1939. Consumption for pickling in the iron and steel industry, for example, was 22.5 percent higher; and in coal products, 21.6 percent higher. Miscellaneous applications required 17 percent more, and rayon and other viscose products an increase of 16 percent. Slightly smaller increases, percentage-wise, occurred in superphosphate manufacture; in other metallurgical operations; in making other chemicals; and in the field of pigments, principally titanium dioxide. Somewhat lesser gains were registered by explosives, textiles and petroleum refining.

An accompanying tabulation summarizes the performance, from 1938 to 1940 inclusive, of sulphuric acid production and the raw materials employed in its manufacture. These data are based on trade and *Chem. & Met.* estimates and figures published by the U. S. Bureau of Mines. Sulphur mining, exports, shipments, and stocks at mines, plus pyrites imports, domestic pyrites consumption and byproduct acid production at smelters, for 1938 and 1939, are taken from Bureau of Mines figures. Most other data are estimates.

Sulphur mining, including a small amount produced in California and Utah, stood at the high level of 2,725,000 long tons. This is only slightly less than 1937's record. Both exports and domestic shipments were slightly above the earlier 1937 peak.

Sulphuric acid in fertilizer plants



A small quantity of byproduct elemental sulphur also entered the picture. About 28,000 long tons was imported from the Trail, B. C., smelter by the Northwest paper industry while perhaps 4,000 tons recovered from wet gas purification processes went into sprays and insecticides. In addition, acid was produced from byproduct H_2S recovered from petroleum and coke oven gases, to the extent of probably 80,000 short tons (50 deg. Bé. basis).

After deductions for estimates of non-acid uses of sulphur and for probable increase in users' stocks, there appears to have been sufficient sulphur remaining to produce about 6,090,000 short tons of acid (50 deg. Bé. basis). With imported pyrites estimated at 435,000 long tons and domestic pyrites at 520,000 tons, another 2,015,000 short tons of acid seems to have been made from these materials. Adding the 1,000,000 tons believed to have been produced as a byproduct at copper and zinc smelters, and the already mentioned production from byproduct H_2S, gives a total acid yield in the neighborhood of 9,185,000 short tons.

New sulphuric acid plant capacity totalling somewhat more than 200 tons per day of contact acid (100 percent basis) went into operation in 1940. One of the plants is employing a combination of brimstone with a small quantity of H_2S recovered from coke oven gas. Another is operating on a combination of brimstone, waste SO_2, refinery H_2S and acid sludge. A small increase in chamber plant capacity was realized by the addition of Mills-Packard chambers to two existing plants. New plants scheduled to go into operation in 1941 will total about 900 tons per day of contact acid capacity (100 percent basis). New Canadian contact plants of 350 tons daily capacity will be ready for operation early this year.

What the nation's sulphuric acid balance is likely to be during the next

S

AND FORECASTS

REPORT OF CHEMICAL PROCESS INDUSTRIES

Estimated Distribution of Sulphuric Acid Consumed in the United States

(Basis 50 deg. Bé.)

Consuming Industries	1938 Short Tons (Revised)	1939 Short Tons (Revised)	1940 Short Tons
Fertilizers	1,900,000	1,970,000	2,260,000
Petroleum refining	1,100,000	1,210,000	1,270,000
Chemicals	800,000	975,000	1,090,000
Coal products	585,000	740,000	900,000
Iron and steel	590,000	980,000	1,200,000
Other metallurgical	350,000	570,000	640,000
Paints and pigments	430,000	520,000	570,000
Explosives	140,000	160,000	175,000
Rayon and cellulose film	320,000	405,000	470,000
Textiles	90,000	116,000	125,000
Miscellaneous	355,000	384,000	450,000
Totals	6,660,000	8,030,000	9,150,000

Data and Estimates on U. S. Sulphur Activity and Sulphuric Acid Production, 1938-1940

(Sulphur and pyrites in long tons; acid in short tons, 50 deg. Bé.)

	1938	1939 (Revised)	1940
Sulphur mined	2,393,408	2,090,979	2,725,000
Sulphur exports	579,107	627,819	760,000
Domestic shipments[1]	1,049,740	1,605,998	1,795,000
Approx. mine stocks at end of year	4,200,000	4,000,000	4,170,000
Non-acid uses of sulphur	350,000	495,000	[2]600,000
Sulphur available for acid	100,000	1,111,000	1,223,000
Change in consumer stocks	−50,000	+100,000	+50,000
Acid from sulphur	3,900,000	5,250,000	6,090,000
Pyrites imports	334,234	482,336	435,000
Change in consumer stocks	....	+90,000	....
Domestic pyrites	555,629	516,408	520,000
Acid from pyrites	1,785,000	1,917,000	2,015,000
Acid from smelters	860,000	974,000	1,000,000
Acid from hydrogen sulphide	40,000	68,000	80,000
Total sulphuric acid made	6,585,000	8,209,000	9,185,000
Acid reported by Census	....	7,649,814	....

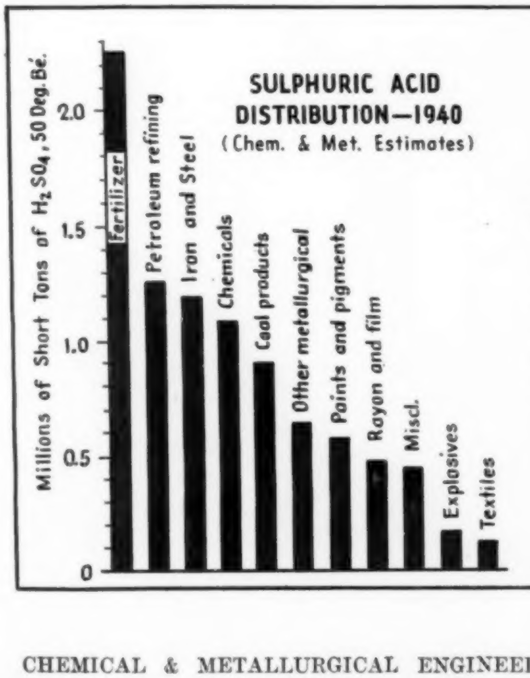
[1] Does not include imports of about 2,600 tons in 1938; 14,000 tons in 1939; 28,000 tons in 1940 from Trail, B. C., nor shipments of about 4,000 tons of by-product elemental sulphur from fuel gases. Both used for purposes other than acid; not included above in " non-acid uses."

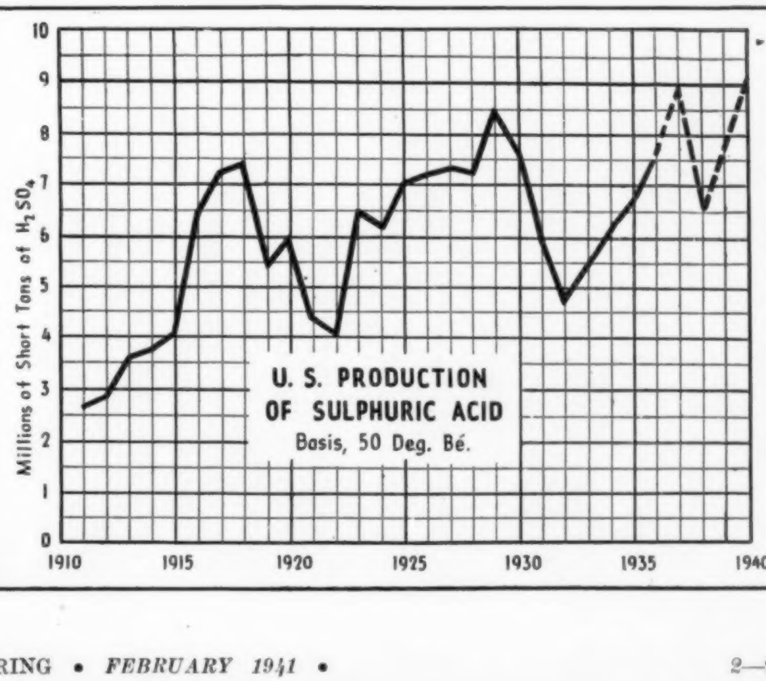
[2] Includes possible 20,000 tons increase in stocks of consumers.

few years while munitions production is being widely expanded is somewhat difficult to appraise. Although nitration of such materials as cellulose, toluol and phenol requires large quantities of H_2SO_4 in mixed acid, and also for the concentration of nitric acid, still, most of this sulphuric acid can be recovered and reconcentrated. However, in order to preserve the proper HNO_3-H_2SO_4-H_2O balance in its nitrating acid, the explosives industry must add oleum, which means a continual rejection of spent acid, equivalent to the oleum intake, to preserve the balance and prevent build-up of impurities.

During World War I, this excess acid was used in making nitric acid from Chile saltpeter and hence its disposal was no problem. Now, however, practically all HNO_3 is made by ammonia oxidation, which requires no sulphuric acid except when it is necessary to concentrate the HNO_3 above the 60 percent product obtained in the oxidation process. Then a loss of sulphuric acid occurs, equal to about 5 percent of the concentrated nitric.

A problem in the disposal of spent sulphuric acid will, therefore, have to be faced. It is understood that consideration is being given to the plan of employing such acid in superphos-





phate manufacture and possibly in steel pickling, provided use can be arranged at not too great a distance from the explosives plants. This would seem, however, to mean that considerable chamber plant capacity will be displaced by spent acid and the problem of employment of this chamber capacity will doubtless arise. With approximately half of the country's present capacity in chamber plants, there is some question whether present strong acid capacity will be sufficient, or whether additional contact and/or concentrating capacity may not be needed.

It has been suggested that chamber plants can aid in the munitions program by shipping 60 deg. acid to nearby contact plants, there to be used as "drip acid," instead of water. However, it has been pointed out that this proceeding is useful only when 98 percent or weaker acid is being produced by the contact plant. Munitions makers want 104 and 109 percent acid and are not interested in 98 except perhaps for initial make-up. In times of high atmospheric humidity, the quantity of water extracted in the air drying towers practically equals the water requirement of 109 percent acid so that little drip acid can be used. If chamber plants are to be employed to step up contact plant capacity, it would seem to be necessary to concentrate the chamber acid to 93 or 96 percent in which case a fairly sizable increase in oleum capacity can be achieved.

NITRIC ACID

Nitric acid is more likely to prove a bottleneck than sulphuric. Present ammonia capacity of the United States appears to be approximately 300,000 tons of synthetic NH_3, plus perhaps another 200,000 tons per year of byproduct ammonia. On page 753 of our November 1940 issue we estimated that a 2,000,000-man army, assuming 1 lb. per man per day each of propellent powder and high explosives, will demand 400,000 tons of smokeless powder, 300,000 tons of TNT, 125,000 tons of ammonium nitrate and 13,000 tons of picric acid annually. This program is estimated to call for about 625,000 tons of HNO_3 (100 percent basis) plus 25,000 tons of ammonia as such, or in terms of ammonia, 200,000 tons of NH_3 equivalent. With present normal peace-time chemical nitrogen requirements for domestic use in the neighborhood of 650,000 tons ammonia equivalent, there appears to be a shortage in present domestic ammonia capacity of about 350,000 tons. In the last fertilizer year about 150,000 tons of this deficiency was made up by imports, chiefly of Chile saltpeter, sulphate of ammonia and cyanamide. A special military reserve of Chile nitrate (300,000 tons = 58,000 tons NH_3 equivalent) is being accumulated here and in Chile by the U. S. government. However, plans are being made to provide munitions for a 4,000,000-man army, and it is likely that the proportion of NH_4NO_3 used, compared with other explosives, will increase beyond that indicated above.

Nitric acid requirements in 1940 were about 200,000 tons, with perhaps 170,000 tons normal. (The Census shows production of 175,860 tons in 1937 and 167,740 tons in 1939). As present capacity is estimated at about 200,000 tons, the defense deficiency of this material (based on a 2,000,000-man army) seems to approximate 600,000 tons. Although the capacities of the three new ammonia plants and the several ammonia oxidation plants now building have not been announced, it is presumed that they contemplate eliminating most of the deficiencies, without much reliance on imports.

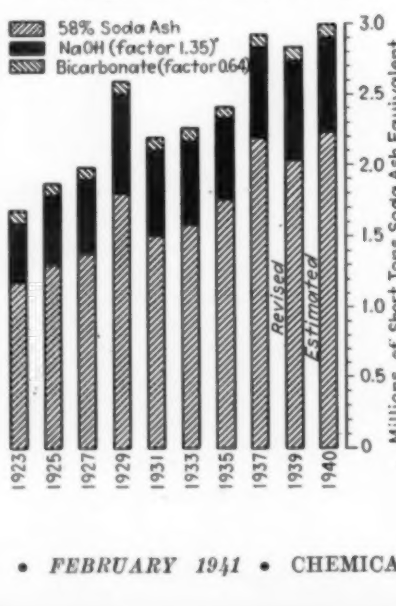
Hydrochloric acid requirements are normally not large (78,848 tons 100 per cent in 1939 and 71,166 tons in 1937 as shown by the Census), and are not likely to increase markedly owing to defense requirements. The only possibility of a pinch seems to be that excessive chlorine demand may result in diversion of chlorine from the probable 10,000 tons of HCl now being produced from chlorine and hydrogen. Even this is not likely.

ALKALIS AND CHLORINE

Production figures for soda ash, caustic soda and chlorine all reached new high levels in 1940, with a particularly large gain in the case of chlorine. Except for a relatively slack period in the Spring, chlorine demand was exceedingly active and for that reason electrolytic production of caustic soda for the first time exceeded production of this material by the lime soda process.

ALKALI PRODUCERS established new records all along the line in 1940, surpassing the previous peak years of 1937, in the case of soda ash, and 1939 in the cases of caustic soda and chlorine; and leaving the fabled 1929 far behind. Soda ash production, for example, was 4 per cent over 1937 and nearly 18 per cent above 1929. Corresponding increases in the case of caustic soda were 6.8 per cent up from 1939 and 43 per cent above 1929; and for chlorine, increases of 24.7 per cent and 187 per cent above 1939 and 1929, respectively. Chlorine production was at a near-capacity rate,

Production for sale of principal ammonia soda products (ash equivalents)



Production of Caustic Soda in the United States

(Short Tons)

Year*	Lime-Soda	Electrolytic	Total
1921	163,044	75,547	238,591
1923	314,195	122,424	436,619
1925	355,783	141,478	497,261
1927	387,235	186,182	573,417
1929	524,985	236,807	761,792
1931	455,832	203,057	658,887
1933	439,363	247,620	686,983
1935	436,980	322,401	759,381
1937 (revised)	488,807	479,919	968,726
1939 (revised)	530,907†	494,104†	1,025,011
1940 (estimated)	505,000	595,000	1,095,000

* Figures for 1921–1939 are from the U. S. Bureau of the Census. Electrolytic caustic soda figures do not include that made and consumed at wood-pulp mills, estimated at about 30,000 tons in 1927 and 1929, at above 24,000 tons in 1931, 21,000 tons in 1933, 20,000 tons in 1934, 17,000 tons in 1935, 19,000 tons in 1936 and 1937, 18,000 tons in 1938, 21,000 tons in 1939, and 22,000 tons in 1940.

† Estimated. 1939 Census gives 523,907 tons of lime soda caustic and 426,250 tons of electrolytic caustic made for sale. The total of 74,854 tons made and consumed is not distributed by process. We estimate 7,000 tons of lime soda caustic made and consumed.

with the exception of a period in the Spring of 1940.

In spite of the high level of chlorine demand, there appears to have been little of the piling up of caustic soda stocks which plagued the industry during several recent years. This was due in part to increasing capacity of processes producing chlorine without caustic soda, in part to the fact that all of the ammonia soda ash manufacturers now operate electrolytic caustic soda plants, in addition to their lime soda equipment, on which account they were less inclined to push caustic soda production by the latter method. This trend is interestingly portrayed by the curve which appears below, showing the breakdown between electrolytic and lime soda caustic since 1921. With lime soda caustic making up 72 percent of the total in 1923, its contribution has fallen continuously to an estimated 46 percent in 1940.

Soda ash production is estimated to have reached the total of 3,157,000 short tons in 1940. This is at the rate of about 83 per cent of the capacity existing at the beginning of the year. This production was made up of about 3,025,000 tons of ammonia soda ash, about 107,000 tons of natural and 25,000 tons of electrolytic soda. In comparison, the production reported by the Census for 1939 was 2,829,735 tons of ammonia soda, and 132,897 tons of natural and electrolytic soda. Corresponding figures for 1937 were 2,918,668 and 118,753 tons.

Soda ash sales also increased to new levels, although not to quite the extent of the production increase. Sales of ash, estimated at 2,372,000 tons in 1940, exceeded those reported by the Census, 2,146,161 tons in 1939 and 2,323,759 tons in 1937, by 10.5

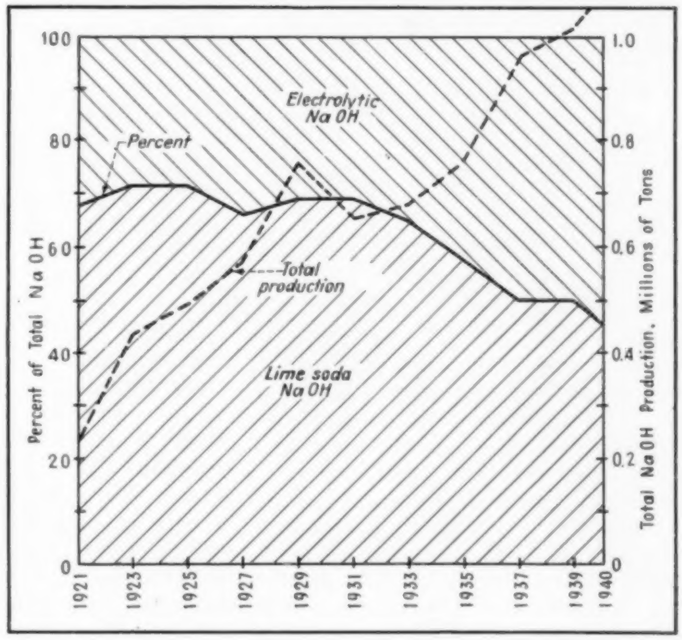
Estimated Distribution of Caustic Soda Consumed in the United States

Consuming Industries	1938 Short Tons	1939 Short Tons (Revised)	1940 Short Tons
Soap	95,000	100,000	95,000
Chemicals	138,000	195,000	220,000
Petroleum refining	80,000	84,000	88,000
Rayon and cellulose film	156,000	196,000	230,000
Lye	40,000	44,000	48,000
Textiles	36,000	44,000	48,000
Rubber reclaiming	11,000	18,000	20,000
Vegetable oils	21,000	17,000	16,000
Pulp and paper	37,000	47,000	50,000
Exports	101,000	130,000	105,000
Miscellaneous	150,000	150,000	175,000
Totals	865,000	1,025,000	1,095,000

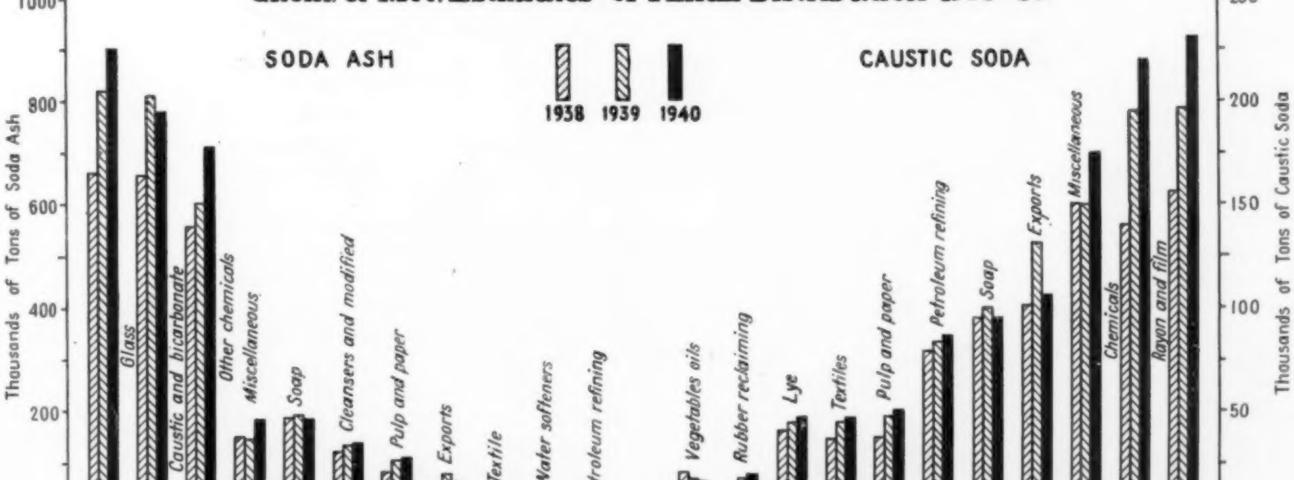
Estimated Distribution of Soda Ash Consumed in the United States

Consuming Industries	1938 Short Tons	1939 Short Tons (Revised)	1940 Short Tons
Glass	660,000	820,000	904,000
Soap	187,000	190,000	182,000
Caustic and bicarbonate	655,000	810,000	780,000
Other chemicals	556,000	600,000	710,000
Cleansers and modified sodas	120,000	130,000	135,000
Pulp and paper	85,000	105,000	111,000
Water softeners	27,000	28,000	32,000
Petroleum refining	10,000	11,000	12,000
Textiles	30,000	43,000	45,000
Exports	51,000	80,000	61,000
Miscellaneous	149,000	144,000	185,000
Totals	2,530,000	2,961,000	3,157,000

Caustic soda production from 1921 to 1940, showing breakdown between electrolytic and lime soda output



Chem. & Met. Estimates of Alkali Distribution 1938-40



and 2 per cent respectively. The increase in total consumption of ash was in spite of the fact that its employment in the manufacture of lime soda caustic was considerably less than in 1939, in which year the manufacture of lime soda caustic established its all-time record.

Two accompanying tabulations reveal our current estimates of the consumption of soda ash and caustic soda in the principal consuming industries. As in the report for 1939, the soda ash tabulation is based on the distribution of the entire consumption, including that converted by primary producers to bicarbonate and caustic soda. Prior to the 1939 report, our distribution estimates included only that soda ash sold by the manufacturers. The column for 1938 in the current report has, as will be noted, been converted to the total distribution basis. The chart for ammonia soda products, however, has been kept on a "for sale" basis.

Soda ash consumption increased an estimated 6.7 per cent over 1939, with the largest percentage increases among such industries as glass, chemicals, water softeners and miscellaneous uses. Declines were registered in soap, lime caustic soda production and exports. The glass industry experienced an all-time high, slightly exceeding the 1937 peak. Soap production, however, fell off during the year in spite of the substantial last-quarter recovery. Although modified sodas receded, this was more than offset by increases in special cleansers.

Caustic soda production, which is given in detail in an accompanying tabulation, increased slightly over the previous record year of 1939, reaching an estimated total of 1,095,000 tons compared with 1,025,000 tons in the earlier year. As noted above, the remarkable feature of this record is not so much the increase, as its manner, for electrolytic caustic for the first time passed the lime soda product, accounting for some 595,000 tons, to 505,000 tons of the latter. Thus lime soda caustic actually declined by nearly 5 per cent, while electrolytic increased by over 20 per cent compared with 1939. In connection with the footnote to the caustic soda production table, it should be noted that the small quantity of caustic estimated as made and consumed principally in pulp mills, but not reported by the Census, is by no means all the caustic made at such mills. Part,

(Please turn to page 97)

FERTILIZERS AND MATERIALS

Total fertilizer consumption in 1940 was slightly above that of 1939, but still below the peak year of 1937. The year showed continuation of the trend toward higher plant food content and also toward the use of more concentrated materials. Meanwhile the price per unit of plant food has dropped markedly in recent years. At present, domestic capacity for all fertilizer chemicals is on the increase, including phosphorus and phosphoric acid, ammonia, and potash.

A LITTLE OVER 8 million tons of fertilizer was used in the United States during 1940. This included commercial sales of about 7.7 million tons, and government distribution of approximately 350,000 tons. The aggregate usage was, therefore, about 2 percent above the preceding year, but still below the all-time record in 1937 tonnage consumption. The gain over 1939 was most marked in government distribution, as the commercial sales that year were 7.58 million tons, whereas government distribution was only 220,000 tons. Except in the case of certain large new government "marketings," as a part of the Soil Improvement program, the distribution geographically was about usual.

Included in the 1940 fertilizer consumption was the equivalent of about 4.7 million tons of 16 percent superphosphate. Much of the material used was of higher concentration, a considerable quantity being of "triple super" grade; but the 16 percent equivalent was as indicated. The commercial fertilizer marketed was slightly more concentrated than ever before, averaging about 19.6 percent of plant food in all complete mixed goods used. The government, through both AAA and TVA programs, utilized more of the triple superphosphate than ever before. Still more of that highly concentrated material might have been used in 1940 by these government agencies if the capacity of the industry had been greater. The concentration of plant food indicated above compares with 19.3 percent in 1939, and an average of about 16 percent during the decade beginning 1920.

It is estimated that the farmers paid approximately $27.75 per ton at the farm for last year's purchases, which compares with $27.55 in the preceding year. During the ten years beginning 1921, the average price was $30.90, according to government estimates. The average cost per unit during 1920–29 was $1.93, compared with the 1940 average of $1.32.

Exports and imports of fertilizers and fertilizer materials for the 11 months of 1940, and the comparable period of the two preceding years, is shown in Table I. These data demonstrate that the United States is slightly an importer nation. This result has come about because of the decline in phosphate rock exports while imports of sodium nitrate have been advancing. Year totals for 1939 and 1940 would, it is believed, show no significant difference in trend.

Considerable emphasis continues on the minor plant food requirements of certain crops on certain soils. Most important of these minor plant foods is magnesium needed to correct soil deficiencies in some of the important southeastern states. Addition of magnesium to many fertilizers is now the regular practice of most large companies.

Perhaps most important in an administrative way to the fertilizer industry during the past year was the protracted proceeding before the grand jury in North Carolina. Earlier anti-trust actions had resulted in a consent decree regarding potash marketing; and late in the year a group of sealed indictments against nitrogen marketing companies was opened and the charges placed on the court calendar for later trial. It is anticipated that certain indictments may be returned in the Federal court also with respect to some of the phosphate rock, superphosphate, and mixed fertilizer companies who have been under investigation for a long period.

The vast majority of fertilizer marketed is "complete," containing nitrogen, phosphate, and potash. About 93.6 percent of all sales are of this character, with about 5.2 percent containing only phosphate and potash. Various other mixtures of two plant foods form a negligible percentage of the total. Of course, much of the "direct application" goods are single industrial materials not included in these figures.

Mixed fertilizers are now typically

from 16 to 23 percent plant food. Most of the balance is made up, not of fillers but of the other elements in the fertilizer compounds used. Only about 5 percent of the total tonnage of mixed fertilizer sales is of the so-called "concentrated" type containing 40 percent or more of plant food. There is, however, a growing demand for triple superphosphate. A considerable tonnage of that material was sold by the industry in 1940, and government agencies distributed under demonstration and soil-improvement programs about 200,000 tons.

The materials used in making fertilizer are identified in detail in Table II, one of several tables for which we are indebted to the Synthetic Nitrogen Products Corp. The total of materials here indicated is slightly less than the total United States usage because the table does not include all of the TVA and AAA marketings. Those items amount to about 350,000 tons of materials containing about 123,000 tons of P_2O_5, or about one-seventh of all of this plant food used in the United States.

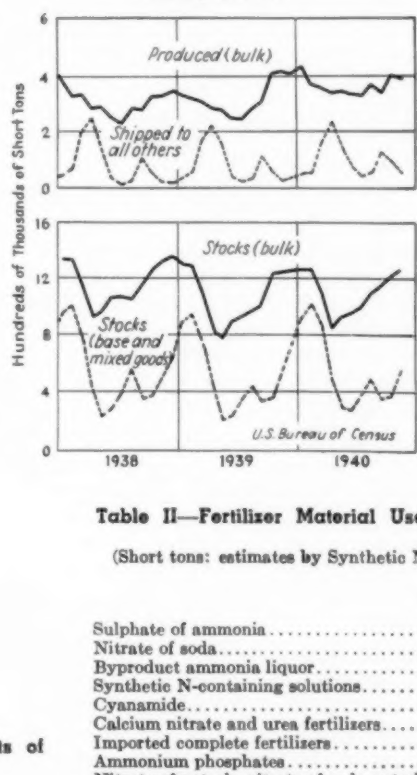
PHOSPHORUS

In the United States there now are about a dozen large electric furnaces in regular operation manufacturing elemental phosphorous or concentrated phosphoric acid. These are owned by four private concerns and one government agency: Victor, Monsanto, and TVA, all located in Tennessee, American Agricultural Chemical, Perth Amboy, N. J., and Phosphate Mining Co., Nichols, Florida. The bulk of production from the industrially owned furnaces is generally used for non-fertilizer materials; but two of these companies are shipping elemental phosphorous in tank car loads to TVA for conversion to concentrated phosphoric acid or triple superphosphate. This practice is expected to increase in 1941. And the capacity of the furnaces (or their number) is also to be increased, it is reported.

The shortage of triple superphosphate will be aggravated in 1941 for several reasons. Both TVA and AAA desire to accelerate their demonstration programs using this material. However, the government has consented to release some of its high concentration plant foods for shipment to Britain in order to save ship space. And 20 percent superphosphate will be used as a replacement, as well as for extending the programs beyond the capacity of high concentration materials.

Large-scale experiments are being continued by TVA on the manufacture and proper farm usage of metaphosphates and calcined phosphate rock. The latter is made by elimination of fluorine from the ordinary rock by heating, sometimes with small chemical addition. Nearly a million dollars was spent during the last fiscal year by TVA on this and similar research or development work related to fertilizer production.

Superphosphate in the United States during 1938-40



Exploitation of Western phosphate deposits continues to be a political rather than an engineering problem. The special congressional committee dealing with that subject made a preliminary report to Congress during January of this year, and requested continuance of authority.

During 1941 it is expected that more of all kinds of fertilizer materials will be used than last year. The only prospective factor which may interfere is a possible diversion of materials from fertilizer to defense or industrial uses. However, there is no present expectation that such diversion will be necessary. In fact, a very great surplus of sulphuric acid for fertilizer use is feared. The reclaimed acid from explosives making will be available for fertilizer manufacture, probably in quantities greater than the present industry can use.

The only reduction of phosphate rock production anticipated will probably come from the difficulty of export, because of both shortage of shipping and inability to reach normal foreign markets.

NITROGEN

During the fertilizer year 1939–40 the United States used for plant food approximately 383,000 tons of nitro-

Table I—United States Exports and Imports of Fertilizers and Fertilizer Materials

(Long Tons)

	January–November		
Exports	1940	1939	1938
Nitrogenous mat'ls......	241,119	152,152	183,371
Phosphate rock.........	654,452	918,858	1,049,491
Other phosphates......	142,693	110,878	113,475
Potash salts............	76,077	116,995	71,177
Other fertilizers.........	31,821	25,178	17,768
Grand Total...........	1,146,162	1,324,061	1,435,282
Imports			
Sodium nitrate.........	636,703	544,872	544,794
Other nitrogenous mat'ls	284,318	442,943	442,056
Phosphate mat'ls.......	75,570	89,593	45,995
Potash salts............	237,162	192,657	312,589
Other fertilizers.........	36,686	46,112	61,171
Grand Total...........	1,270,439	1,316,177	1,406,605

Table II—Fertilizer Material Used in United States, Fertilizer Year 1939-40

(Short tons: estimates by Synthetic Nitrogen Products Corp., for continental U. S. only)

	Total Material	Plant Food N	Plant Food P_2O_5	Plant Food K_2O	Applied* Directly
Sulphate of ammonia..................	513,000	105,600	....	....	158,000
Nitrate of soda........................	748,000	120,200	....	....	648,000
Byproduct ammonia liquor............	35,000	7,500	....	....	....
Synthetic N-containing solutions.......	85,000	38,000	....	....	3,000
Cyanamide............................	138,000	29,800	....	....	83,000
Calcium nitrate and urea fertilizers.....	88,000	21,100	....	....	28,000
Imported complete fertilizers..........	2,000	300	400	400	....
Ammonium phosphates................	67,000	8,800	22,700	....	27,000
Nitrate of potash, nitrate of soda-potash	46,000	6,400	....	7,300	21,000
Other potash materials................	770,000	....	....	373,000	110,000
Cottonseed meal......................	135,000	8,100	3,200	2,300	85,000
Other natural organics................	660,000	32,300	26,000	5,300	160,000
Bulk superphosphate..................	3,355,000	....	630,200	....	†765,000
Basic slag............................	35,000	....	3,500	....	35,000
Bones, bone meal.....................	92,000	2,100	22,100	....	60,000
Ground phosphate rock................	140,000	....	5,600	....	90,000
Sulphuric acid (for acidulating certain organics)..........................	5,000	....	....	....	....
Wood, beet root ashes.................	9,000	....	....	400	5,000
Dolomite, limestone...................	350,000	....	....	....	....
Calcined kieserite and other secondary plant food materials.................	7,000	....	....	....	5,000
Filler.................................	548,000	....	....	....	....
Total tonnage........................	7,833,000	382,700	713,700	388,700	2,283,000

* Materials not used in mixed fertilizers; includes materials used in home-made mixtures except liming materials.

† Includes about 20,000 tons of "basic lime phosphate." Does not include triple super distributed by T.V.A. and A.A.A.

gen contained in a wide variety of fertilizer materials. About 200,000 tons of this was used in mixed fertilizer, where it formed 3.6 percent of the goods used by the farmer. The balance was applied direct to the soil in varying materials which averaged 14.4 percent nitrogen content, being principally nitrate of soda and ammonium sulphate. Industries other than agriculture consumed about 155,000 tons of nitrogen in the various chemical forms indicated by Table III. Exports accounted for about 59,000 tons, and Puerto Rican and Hawaiian consumers used about 37,000 tons of nitrogen. The stocks of nitrogen chemicals on hand at the end of the fertilizer year, June 30, 1940, had increased by about 15,000 tons of nitrogen.

Table IV summarizes the sources of nitrogen chemicals during the fertilizer year referred to; while the synthetic nitrogen balance appears in Table V.

The requirements of nitrogen for the coming calendar year are expected to be a trifle higher for agricultural purposes than the totals indicated above for the last fertilizer year. Industry estimates forecast a requirement of 400,000 tons of nitrogen divided almost equally between that to be used in mixed fertilizer and that to be applied directly to the soil. The requirements for industrial uses other than explosives will probably be slightly higher than during the past year; but the big increase of demand will, of course, be in the explosives industry. The Army now definitely plans to build capacity sufficient to serve a 4,000,000-man army. The capacity will be ready even if production is not immediately required.

It should be noted that either agriculture or the explosives industry can be served by a number of the products indicated in Table V. However, it is not possible to substitute nitrate forms of fertilizer material for ammonia forms in most of mixed fertilizer, at least not beyond the percentages now so used. However, the ammonia type of fertilizer used directly on the soil could be diverted to explosives use and natural sodium nitrate from Chile substituted if this were necessary for defense reasons. At least 35,000 tons of contained nitrogen, equivalent to 200,000 tons of Chilean nitrate, were so used and are at least theoretically available for diversion from fertilizer to military purposes.

Chilean nitrate has continued to be an important item in the imports of fertilizer materials. Table I indicates the quantity of imports during recent years. These imports have supplied typically from 90,000 to 110,000 tons of contained nitrogen for agricultural use and from 3,000 to 4,000 tons for non-agricultural applications. It will be noted that the natural nitrate still exceeds the synthetic nitrate in quantity, but that the synthetic industry has been pressing close on the heels of Chile as a source of our nitrate of soda during recent years.

Late in 1940 the United States consummated an arrangement by which a government agency, Reserve Supplies Corp., bought 300,000 tons of natural Chilean nitrate, of which one-third is to be brought to the United States immediately. This material forms a military reserve. It may be diverted to agricultural use in order that more ammonia may be sent to explosives plants; or it may be used in old-fashioned niter pots for making nitric acid at such works. Apparently Washington now believes that it is better to provide some of the explosives capacity for the second 2,000,000-man army through explosives plant capacity which will be served by nitrate rather than by synthetic-ammonia units.

Natural organic materials still continue to form an important part of the total fertilizer industry. The surpluses of such materials which cannot be utilized for feeds, and the low grade materials not suitable for feeding purposes, are still used to the extent of nearly 900,000 tons per year, containing nearly 5 percent of nitrogen on the average. Table VI shows the character, tonnage, and typical composition of these materials.

POTASH

Several American firms produced potash in the United States during 1940. The four major producers were three companies mining potash salts near Carlsbad, N. M., and American Potash & Chemical Co., recovering potash salts from the brines of Searles Lake, Calif. A small quantity of potash was recovered by solar evaporation in Utah, and byproduct potash was made intermittently in Maryland from cement-kiln dust and molasses distillery waste.

America can now produce more than adequate supplies of potash raw material for all agricultural and industrial purposes. Furthermore, practically all of the potash specialties required by chemical industry are being made by new effort of various chemical firms, replacing those chemicals formerly imported. At the year end there was, however, not quite enough potash mineral refinery capacity to produce the concentrated fertilizer salts of various types in quantities desired for both domestic use and for export sales. As a result some important policy problems have been encountered by the American producers.

If there were no export sales there would be adequate supply for present and prospective domestic demand for potash chemicals. This has raised the question as to whether American producers should offer any sales for export purpose. In general they have not done so. But some purchasers have undertaken resale of goods bought, and at times this has threatened a shortage of potash supply, especially in the Far West. American refinery capacity is already adequate to care for both fertilizer and industry needs; and primary producers are seeking to restrict marketing to these purposes for the present. Imports have been almost negligible during the year. Exports are prospectively to be limited by the new Export License Controls.

Table III—Consumption of Nitrogen in U. S. Industries Other Than Agriculture

(Estimates for Fertilizer Year 1939–40 by Synthetic Nitrogen Products Corp.)

	Equivalent Short Tons of Nitrogen
Synthetic nitrogen	
Nitrate of soda (100,000 tons)....	16,300
Anhydrous ammonia and other materials....................	115,700
Byproduct nitrogen	
Liquor or anhydrous ammonia....	14,400
Sulphate of ammonia............	900
Chilean nitrate of soda (20,000 tons)..	3,200
Other imports (cyanamide, cyanides, etc.)............................	4,500
	155,000

Table IV—Sources of Nitrogen Materials in the United States, Fertilizer Year 1939-40

(Estimates by Synthetic Nitrogen Products Corp.)

	Equivalent Short Tons of Nitrogen
Supplies (without stocks on hand)	
Domestic production	
At byproduct plants..............	159,900
At synthetic plants...............	247,500
Sub-total....................	407,400
Imports	
Sulphate of ammonia..............	21,200
Chilean nitrate (soda and soda-potash).........................	118,300
Cyanamide.......................	35,500
Other imports of chemical origin...	24,000
Sub-total....................	199,000
Natural organics (as far as used for fertilizer purposes)................	42,500
Grand total..................	648,900

Consumption of potash in fertilizers during 1940 is believed to have been a trifle higher, in percentage of mixed fertilizer sold, than in any previous year. This represents a continuance of the uptrend in concentration of plant food which has been stimulated by the educational effort of American Potash Institute. The same trend is expected to continue for some time to come if supplies are adequate, as expected. Where temporary shortages threaten locally, it is hoped that the low grade potash minerals which can be mined in abundance will be substituted for certain purposes by fertilizer users until pending expansion of refinery capacity is able to care for every need, including material for export.

Already four companies have announced definite beginning of manufacture of potassium sulphate, two primary producers and two small converters who buy muriate. Production of chlorate of potash, especially for match manufacture, is being undertaken by two firms. One plant is connected with a primary mineral producer at Carlsbad and the other is being built for use of power at the Bonneville Dam. Several smaller operations have been announced for the manufacture of caustic and other needed potash specialties.

Altogether the production of primary potash in the United States during 1940 appears to have been about 25 percent above that in the preceding calendar year. This is, of course, an all-time record. Preliminary tonnage guesses indicate that the K_2O content of this production approximated 380,000 short tons.

Table V—U. S. Synthetic Nitrogen Balance, Fertilizer Year 1939-40

(Based on estimates prepared by Synthetic Nitrogen Products Corp.)

	Equivalent Short Tons of Nitrogen
SUPPLIES	
Estimated output of	
Plant at Hopewell	120,000
Plant at Belle	100,000
Shell plant	15,000
Several small plants	12,500
Total	247,500
DISPOSITION	
Consumed by U. S. agriculture in N-containing solutions, ammonia and ammonium phosphate	52,500
Consumed by U. S. agriculture as nitrate of soda (156,000 tons)	22,800
Consumed by Puerto Rican and Hawaiian agriculture as nitrate of soda (4,000 tons)	2,400
Consumed as sulphate of ammonia, mostly in U. S. agriculture (65,000 tons)	13,400
Consumed as nitrate of soda by U. S. industries (90,000 tons)	16,300
Consumed as ammonia and miscl. by U. S. industries	113,500
Exported as nitrate of soda (143,000 tons) and as urea and similar	20,600
Exported as anhydrous ammonia, etc.	6,000
Total	247,500

Table VI—Consumption of Natural Organics for Fertilizer Purposes in Continental United States, 1939-40

(Source: Synthetic Nitrogen Products Corp.)

Materials	Short Tons of Material	Short Tons of Nitrogen
Cottonseed meal	135,000	8,100
Other seed meals	20,000	1,000
Process tankage	100,000	8,400
Animal tankage	40,000	3,000
Fish scrap and meal	80,000	6,400
Dried blood	10,000	1,300
Garbage tankage	60,000	1,700
Sewage sludge	100,000	4,600
Guano	6,000	500
Castor and tung pomace	15,000	800
Cocoa and other shells	25,000	600
Various rough ammoniates	10,000	600
Dried manure	60,000	800
Bones and bone meal	80,000	2,000
Bone black, dissolved	8,000	100
Tobacco stems	80,000	1,600
Peat	50,000	1,000
Totals	879,000	42,500

ALKALIS AND CHLORINE

(*Continued from page* 94)

but only part, of the caustic produced in the pulp industry is regularly reported in the Census total.

Caustic soda consumption during 1940 exceeded 1939 by about 6.8 per cent, as shown in our tabulation of uses by consuming industries. Large increases were registered in making other chemicals, in the rayon and cellulose film industry and in miscellaneous applications. Declines occurred in soap making, in vegetable oil refining and in exports. The rayon industry again, as almost without exception in the past, established a new high record. On the other hand, exports decreased, on account of war-time conditions, while the fall in vegetable oil refining is attributable to exceptionally low lard prices during the year, which limited the scope of the vegetable oil industry.

Chlorine production in 1940 was one of the outstanding events in the alkali year. Estimation of the total as 605,000 tons produced contains several uncertainties which make the figure one to be accepted with caution. Nevertheless, the increase over 1939 was definitely large and production was not far below the industry's capacity. According to Census figures for 1939 chlorine production was 485,554 tons, of which approximately 440,000 tons would have been made with the electrolytic caustic reported for that year, leaving but 45,000 tons to be made with caustic potash, metallic sodium, magnesium, electrolytic sodium carbonate and synthetic sodium nitrate produced by Solvay's nitrosyl chloride process. Actually, trade opinions place the estimate of chlorine produced from the various non-NaOH sources in 1939 at considerably more, perhaps as much as 75,- 80,000 tons. Therefore, for 1940 we estimate 80,000 tons of chlorine from non-NaOH sources, plus 525,000 tons with NaOH, totaling 605,000 tons. In spite of the high figure for NaOH chlorine, the estimate of 1941 capacity is at least a third greater, while capacity for the non-NaOH product may at present be as high as 100,000 tons, with 10,000 tons more in the offing when new projected capacity at Hopewell goes into operation.

Among the trends in the alkali industry, the following will bear watching. Considerable soda ash is now being used in mechanical combination with sulphur as synthetic salt cake, and used in the pulp industry. While this product cannot replace salt cake in other applications, its success in black ash furnaces appears to be assured. Another application of soda ash which may prove decidedly interesting is as a flux and desulphurizing agent in ferrous metallurgy. In Europe it has been used in the blast furnace to replace a much larger quantity of lime, resulting in reported increases in furnace capacity of 20-30 percent. It is being actively investigated in the United States by the foundry industry, which is considering its use in the cupola and ladle for its desulphurizing ability. Although the economics of its application in the blast furnace is questionable in normal times, soda ash may prove a valuable means of extending furnace capacity in the present emergency.

Trend toward shipment of liquid caustic in higher concentrations has continued and 50-70 percent solutions are now the commonly handled concentrations. Development of coatings for tank car interiors has been actively pursued, to meet the requirements for iron-free caustic, and the construction of insulated cars has facilitated the shipment and handling of liquid of the higher concentrations.

PLASTICS IN 1941

The plastics industry is retaining its youth and vitality. Established materials are constantly being improved and new ones developed. The volume consumed in old applications is on the increase and new uses are growing by leaps and bounds. Phenolic, urea, cellulose acetate, cellulose acetate butyrate, vinyl, and acrylic plastics made large gains in 1940. Vinylidene chloride and melamine resins are newcomers that show great promise of becoming important members of the plastics group.

PLASTICS have an opportunity to play two important roles in the national defense program. First, they can be used in the construction of airplanes, gas masks and other equipment for the Army and Navy. And second, plastics can be used in consumer products in order to free strategic metals for defense needs.

Although our defense program is still in low gear and designs and plans for the airplane, tank, truck, gun, rifle and other machine requirements are still on the drawing boards, plastics have already been specified for numerous parts. Much of the increase in the output of plastics last year may be attributed to these same requirements. As yet we have seen little of the substitution for strategic metal for that will be a second phase that is almost certain to follow. These new demands may give an added impetus to an industry that already is growing amazingly fast as is shown by the record of the last few years.

Cellulose acetate continues to make rapid strides forward, notwithstanding the fact that it has now lost all but an exceedingly small percentage of the safety glass market which it monopolized a few years ago. Production of sheets, rods, tubes and molding powder has increased from 14,224,797 lb. in 1938 to about 24,000,000 last year. Molding powder was responsible for most of the gain particularly in the last year when 15,000,000 lb. were produced which compares favorably with the 11,654,928 lb. of 1939. A further indication of the growth of cellulose acetate plastics is the progress that has been made by one producer of the flake material from which the molding powder is made, the Hercules Powder Co. It has, since entering the field four years ago, on two occasiosn doubled the capacity of its plant. Present capacity is approximately 10,000,000 lb. annually.

Probably the most important development in cellulose acetate in the past year is entrance of material of higher acetyl content in commercial production. This material, because of better dimensional stability under heat and moisture and lower water absorption than regular cellulose acetate, is replacing the older type of acetate in many applications.

The price of cellulose acetate molding powder in granular form ranges between 50 cents and 44 cents per lb., according to color and quantity. This is a reduction of 2 cents from a year ago. Standard types of acetate flake are now 30 cents per lb., 3 cents lower than they were a year ago.

Cellulose acetate butyrate was introduced in 1938. Production has multiplied many times during 1940, although it is still in the introductory stage. This material is suitable for injection molded plastics and in smaller quantity in protective coatings, particularly outdoor clear lacquers for metal. It is produced by Tennessee-Eastman Corp. and Hercules Powder Co. Cellulose acetate butyrate appears to offer greater possibilities for continuous extrusion than does any other plastic. Incidentally, this type of molding is new and the possibilities are so great that it is expected a more rapid expansion in this field will occur than was experienced when injection molding was introduced. In addition to rods and tubes and flat strips of various dimensions this process provides a ready means of making strips of special profile, for innumerable uses, displacing aluminum and chrome plate in many applications. The new models of Chrysler and Ford automobiles are using large quantities of the extruded acetate butyrate for interior trim. The price of extruded forms, based on weight, is about twice that of the molded material.

Current price of cellulose acetate butyrate flake material is 43 cents per lb. on lots of 5,000 lb. or over, and 44 cents on 1,000 to 4,900 lb. While the present price of the molding composition in lots of 5,000 lb. or over is 49 cents per lb. and in lots of less than 100 lb. the price is 55 cents. In any comparison of the prices of cellulose acetate and cellulose acetate butyrate it is important to consider the specific gravities of the two materials, that of the former is 1.3 and the latter 1.2.

Nitrocellulose has not been thriving any too well in recent years. The oldest of all plastics appears to be losing out to the newer materials because of its flammability. Production of nitrocellulose reached a peak of approximately 27,700,000 lb. in 1923. By 1937 it had dropped to 18,100,000, in 1939 to 13,373,000 lb., and further to about 11,800,000 lb. last year. In the lacquer field the alkyd resins have had much greater growth in recent years percentagewise, but in spite of this, the lacquer industry consumed more nitrocellulose last year than in any year in the history. About 80 percent of nitrocellulose plastics is disposed of to outside firms in the form of sheets, rods and tubes, the remainder is consumed by producing plants to make into finished products.

Ethyl cellulose took a more important place in the field during 1940. Hercules Powder Co. produces the material from which a plastic can be made, and Dow Chemical Co. offers an ethyl cellulose molding plastic. Among the principal markets were automobile and aircraft high tension electrical insulation, a base for sound recordings where its excellent toughness over a wide range of temperature recommends it, and in injection and compression molded plastics. A transparent foil is being made from ethyl cellulose which is competing with Cellophane and similar wrapping materials. It is also being used to make rigid containers. The transparent boxes can be easily made and printed; they are tough and flexible.

The carload (16,000 lb.) price on ethyl cellulose for converting into molding compound is 45 cents per lb., and 47 cents on lots of 500 lb. and over.

Methyl cellulose, in a water soluble form, of domestic manufacture was offered to the trade a little over a year ago. Since introduction, it has found wide acceptance in a variety of fields such as paper, paint, pencil, leather, textiles, and cosmetic industries.

Methyl cellulose yields clear, practically neutral solutions in water, and is odorless, colorless, and non-toxic. Its coatings, besides being tough and flexible, are grease proof. Domestic production is supplied in seven viscosities, namely, 15, 25, 50, 100, 400, 1,500, and 4,000 centiposes as

determined on a 2 percent concentration in water.

The carload (30,000 lb.) price on the methyl cellulose is 47 cents per lb., 50 cents on 2,000 lb. lots and 55 cents on 100 lb. lots. Dow and Hercules offer this cellulose material.

Vinyl resins may have surpassed the ureas in volume of production although data are not available. Carbide & Carbon Chemicals Corp. is a leading producer. That organization together with E. I. du Pont de Nemours & Co. and Shawinigan Resins Corp. (jointly owned by Monsanto and Shawinigan Chemicals, Ltd.) produce all the polyvinyl butyral consumed in the manufacture of safety glass. Carbide & Carbon has under construction at Bound Brook, N. J., a plant that, when completed will greatly increase the company's present capacity for the fabrication of vinyl resins. B. F. Goodrich Co. and Carbide & Carbon make the vinyl chloride resins which are used as a rubber substitute for wire insulation, tubing, impregnating cloth for raincoats and shower curtains, and linings for acid-resistant tanks.

Polyvinyl butyral has within the short period of two or three years replaced cellulose acetate in almost all safety glass used in automobiles. It is estimated that in the neighborhood of 75 percent of all the inter-layer material in glass made in 1940 is this resin. The total resin consumed in this application may have been as high as 5,000,000 lb.

Vinyl resins are receiving much newspaper publicity as a result of their use for women's apparel. Filter cloth made from these resins is fast becoming increasingly popular for use in handling industrial chemicals. Such resins are showing promise as adhesive for metal laminations in motors. Their use as an adhesive in paper has increased considerably. They are used on the inside of photoflash bulbs as the "holding" material, for cockpit enclosure in airplanes, to some extent for windshields and numerous other uses.

The copolymer of vinyl chloride and vinyl acetate in large lots sell at 55 cents to 48 cents per lb. The polyvinyl acetate sells at 40 cents per lb. and the polyvinyl chloride at 48 cents per lb. The polyvinyl butyral brought a price of $1.25 per lb.

During the past few months Dow Chemical Co. introduced a vinylidene chloride plastic. One of its most outstanding features is extremely high tensile strength. It has a wide transparent color range and is resistant to water and chemicals. It is being used in women's wear items such as felt hats, and dress trimmings. An important use suggested is in upholstery as a substitute for natural rattan. Some of the upholstery has already been tried in the New York City subway cars. It has been used in lines and leaders in the field of commercial and sport fishing. It may be molded by extrusion, injection and compression methods.

Polystyrene resins are produced by Dow, Monsanto and Bakelite companies. It is probable that Catalin will soon enter the field. While the resin promises to become one of the most important of the group in the neighborhood of 1,500,000 lb. were produced last year.

Uses of polystyrene include television coil forms, high and low frequency radio insulating parts, closures for mineral acids, cosmetic containers, instrument housings, liquor dispensers, transparent packages, a wide variety of refrigerator parts and automobile speedometers, clock crystals, aircraft instrument panels, dishes and costume jewelry. The price of polystyrene resins ranges between 45 cents and 60 cents per lb. It is understood that prices as low as 36 cents per lb. for certain grades may be available soon.

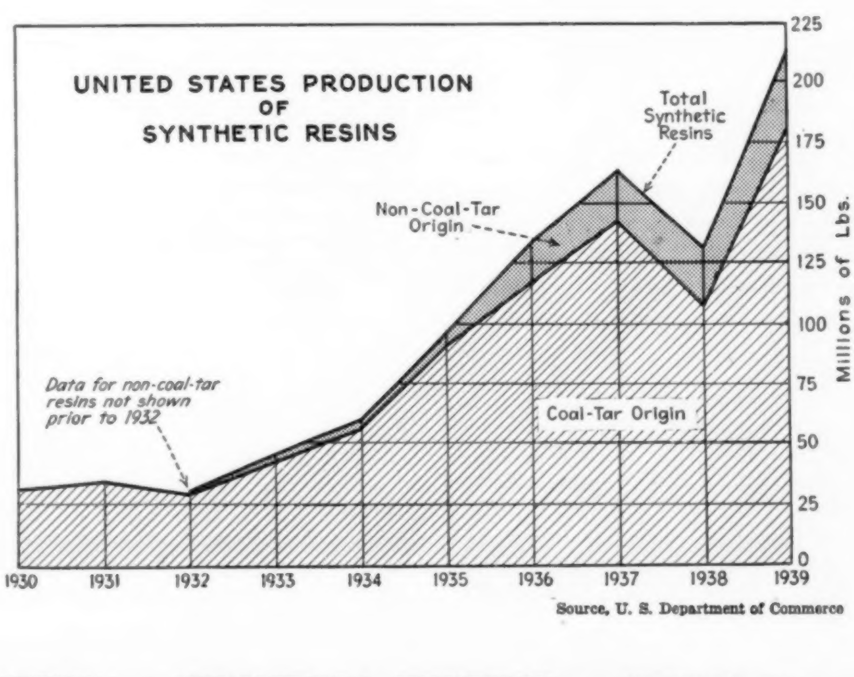
Urea resins enjoyed an increase in sales in 1940 over the previous year. About 11,000,000 lb. of resin was used in molding compositions, 4,000,000 lb. in adhesives, 1,000,000 lb. in laminations, and between 1,000,000 lb. and 2,000,000 lb. in textiles and other applications. The 1939 production amounted to 16,600,000 lb. and the 1938, 8,300,000 lb. Much of this increased production has been due to their introduction into the field of baking enamels which occurred in 1937. These resins are also being used as adhesives for plywood in the furniture and aircraft fields. The principal applications for molding resins include lighting fixtures, buttons, closures, tableware, housings and display containers.

The baking finishes are made by American Cyanamid and Chemical

Synthetic Resins: United States Production and Sales, 1939

Source: U. S. Tariff Commission

Resin		Sales		Unit
Coal-Tar	Production	Quantity	Value	Value
Alkyd:				
Maleic anhydride	6,263,542	4,929,403	$925,048	$0.19
Phthalic anhydride	70,208,098	33,161,064	6,925,898	.21
Tar acids:				
Cresol or cresylic acid	10,515,557	7,893,863	1,063,772	.13
Phenol:				
For casting	8,517,368	8,252,263	3,152,444	.38
For molding	19,421,778	17,396,556	2,571,930	.15
For other uses	27,785,891	25,766,207	3,738,052	.14
Xylenols	442,899	....	....	.....
Xylenols and cresols	....	....	....	.....
Total coal-tar resins	179,337,857	128,419,871	23,028,083	.18
Non-coal-tar resins	....	....	....	.....
Urea	16,569,343	14,556,232	5,288,767	.36
Total non-coal-tar resins	33,689,691	34,876,766	15,983,405	.46



Source, U. S. Department of Commerce

Corp., Bakelite Corp., Libbey-Owens-Ford Glass Co., Rohm and Haas, Reichhold Chemicals, while the first three of these companies are also in the molding plastic field. Cyanamid has another urea resin plant under construction. It will be located at Wallingford, Conn. Carbide and Carbon's Bakelite company is building a urea plant at its Bound Brook, N. J., works. During the year Plaskon passed to the ownership of Libbey-Owens-Ford.

Present prices for urea resins in granular form are from 27½ cents to 35 cents per lb. The liquid resins sell at 22 cents to 24 cents per lb.

Melamine resins, developed by American Cyanamid, are a new group that shows some promise of finding an important place for themselves in the field. They are made by reacting melamine, a derivative of cyanamide, with formaldehyde. They are thermosetting, colorless, lightfast, odorless, tasteless, resistant to hot water, organic solvents and heat. In the molded form these resins may be used in place of urea resins where better water resistance and molding properties are desired. The liquid resins may be used to treat paper and wood veneer for laminating purposes. Surface treatment permits surface color without necessitating the use of a resin throughout the lamination. Prices are higher than for corresponding urea resins. They average about 55 cents per lb.

Acrylic resins are produced by du Pont, and Rohm and Haas, and it has been reported that Celanese Corp. may soon become a producer as it was recently granted a patent to make them by a new process.

These resins are used for curved airplane windshields and cockpit enclosures, dentures, adhesives, lenses, reflectors for highway lighting, illuminated signs, protective coatings, automobile parts and decorative articles. Also illuminating devices, screens and panels, display fixtures, furniture. They may be either molded or cast. The 1940 production probably reached 3,000,000 lb. The price range is between 85 cents and $2.25 per lb.

The molding type of phenolic resins made an important gain during the year just closed. The phenolic molding materials produced reached a total of about 82,000,000 lb. of which 50 percent or 41,000,000 lb. is resin. For laminating purposes from 16,000,000 lb. to 17,000,000 lb. of liquid resin of which 6 percent is solid resin was consumed. And probably about 8,000,000 lb. of resin was used in the formulation of protective coatings and for other purposes. Prices range from 12 to 60 cents per lb.

Cast phenolic resins are made by the Catalin Corp. and its licensees, Marblette, Monsanto Chemical, Bakelite, Joanite, A. Knoedler Co. Production increased last year to 6,600,000 lb., a gain of 600,000 lb. over the previous year. The average price remains about 44½ cents per lb. Catalin invested $100,000 during the year in increasing the capacity of its plant 25 percent. The principal applications for the cast phenolics include phonograph decorations, jewelry and dress ornaments, brush backs and radio cabinets. A development of special merit is the improvement in the technique of casting the resins which makes it possible to produce intricate shapes and large pieces.

ALCOHOL AND SOLVENTS

Production of denatured alcohol increased sharply with all consuming industries raising requirements. Other solvents improved to an almost equal extent and in some cases demand ran ahead of supply and the year terminated in a strong statistical position for all products. Inquiry for export was active with many orders unfilled. Prospective requirements may exceed present plant capacities. Prices were firm and moved upward.

WITH AN upward movement in general industry, practically all outlets for alcohol were expanded last year and operations at alcohol plants were speeded up. The output of ethyl alcohol was reported at 263,181,000 proof gal. which represents an increase of 18.7 percent over the 221,629,000 proof gal. produced in 1939. Pennsylvania maintained its position as the leading producing State with the next ranking States, New Jersey, West Virginia, Louisiana, Indiana, and Maryland. Withdrawals of ethyl alcohol also were on a higher scale during the year with the result that stocks at plants were reduced from 14,613,000 proof gal. at the beginning of the year to 9,503,000 proof gal. on Dec. 31.

Activities at denaturing plants likewise were on a more favorable basis, production amounting to 134,238,000 wine gal. of which 116,699,000 wine gal. was specially denatured, and 17,539,000 wine gal. completely denatured, comparing with 99,174,000 wine gal. and 14,747,000 wine gal. respectively for the preceding year. Stocks of denatured at the beginning of the year were 1,170,191 wine gal. at producing plants and 301,694 wine gal. in bonded warehouses and on Dec. 31 they had increased to 1,359,510 wine gal. at plants and 364,756 wine gal. in the hands of bonded dealers. Hence, apparent consumption was somewhat lower than the totals reported for production.

From a price standpoint, 1940 was the best year experienced by the industry in a long time. It is true that some of the early deliveries were against contracts placed in the preceding year at relatively low prices but business placed in 1940 was at higher levels which were well maintained up to the final quarter when further advances were put into effect. The price-cutting competition which had been common in the market in the years immediately preceding was conspicuous by its absence. Early in the year, following the invasion of Norway and the Lowlands, and the increase in British sea losses, the tanker market became very firm and delivered prices for molasses were higher accordingly. Some of the smaller alcohol producers were forced to pay the higher prices almost immediately because they were carrying small supplies of molasses. This was sufficient to cut down competitive selling and the larger producers who were in a more favorable position because they were carrying fairly large inventories, nevertheless were not inclined to exert sales pressure because they realized that replacement costs would make such action inadvisable.

About the middle of the year, demand for alcohol had been stepped up to a point much in line with the rate of production and based on the law of supply and demand, higher sales schedules seemed to be in order and reports were heard to the effect that advances were in prospect but one of the large producers is said to have offered freely for third quarter deliveries at unchanged prices and this checked the expected price movement. However, the market had strengthened sufficiently in the final

quarter for a price advance to which no opposition appeared.

The national defense program, except for its effect on general manufacturing had but little influence on alcohol directly. But with projected powder plants coming into operation in the present year, it is estimated that a potential market for 20,000,000 wine gal. will be opened up. Mobilization of men for training also is expected to extend the use of alcohol in medical supplies and specialized uses. These additional demands together with the anticipated increase in industrial requirements placed the market in a very strong statistical position as the year drew to a close and consumers were active in placing contracts for 1941 delivery. As plants were operating at, or close to, capacities in the latter part of the year, it is evident the question of obtaining supplies will become quite important in the present year if the prospective buying power has been correctly gaged. So far, nothing has been heard regarding plans for extending capacities of fermentation producers but it is expected that synthetic plant capacity will be substantially increased. Some alcohol also may be released for the open market which formerly was used in the manufacture of ethyl chloride as it is reported that this product will be made synthetically in two new plants.

The improved status of the denatured alcohol trade extended to the anti-freeze branch. The price schedule opened at an advance of 5c. per gal. over the level in effect in the latter part of 1939. In justification of the higher price level, it was pointed out raw material costs had advanced and drum prices increased. Several distributors of anti-freeze, anticipating a break in prices in the early fall—as had been customary in previous years—held back their commitments and when supplies became scarce late in the year, these buyers were unable to cover requirements.

The market for industrial methanol was strong throughout the year. Demand for formaldehyde and other products was heavy and entirely in keeping with the high rate of production maintained in the methanol industry. Production of synthetic methanol was close to 45,000,000 gal. which represents an increase of 11,000,000 gal. over the preceding year and a gain of approximately 90 percent in the last two years. During the final quarter, a pronounced shortage of methanol developed and difficulty was found in locating supplies both for domestic use and for export. Attempts to broaden the output of wood distillation methanol met with but little success as it was found not practical to increase production beyond the demand for charcoal as stocks of crude acetic acid had accumulated and the price for methanol did not justify carbonizing wood solely for its production.

It is expected that methanol supplies will be limited in 1941 especially in the first part of the year as export demand has been active with many inquiries going unfilled. There also is the possibility that demand for ammonia will increase to a point where equipment now used for making methanol may be turned over in part to the production of ammonia.

Acetone entered 1940 with the surplus stocks which had weakened prices in 1939, well cleaned up and a strong statistical position ruled thereafter. One of the large producers, evidently under the impression that the market stability was but temporary, was very active on the selling side and also booked large orders for export with the result that he was forced into the open market to cover some of his commitments at prices above the quoted schedule.

Production of acetone was up approximately 30 percent over 1939, part of which was due to export business and part to the increased call from domestic buyers. Exports ran close to 28,000,000 lb. and production is estimated at 130,000,000 lb. Despite this large output, demand was in excess of supply and three of the four producers had production difficulties at one time or another during the year. Two of the fermentation producers experienced plant difficulties and operations at two synthetic plants were curtailed due to gas shortage resulting from restrictions in refining activities. One of the synthetic plants produced acetone from isopropyl alcohol.

Prices for first quarter delivery in the present year were marked up one cent a gal. Offerings still are restricted and there is every indication that a strong market will rule in the immediate future. Promise of larger supplies is found in the report that one of the large synthetic acetone producers will increase production.

Consuming markets for the products which utilize higher alcohols and acetates were in accord with the rise as reported for other solvents. Demand for butyl alcohol and acetate, as usual, vacillated considerably during the year. In the early months, a large back-log from the preceding

Summary of Operations of Ethyl Alcohol Plants Fiscal Years Ended June 30

	1939	1940	Increase
Number of plants operated [1]	36	37	1
Number of bonded warehouses operated	63	65	2
Operations (Proof gal.)			
Production	201,017,546	243,727,756	42,710,210
Removed to bonded warehouses	200,055,093	242,128,867	42,073,774
Withdrawals from bond, total [2]	201,731,498	251,820,728	50,089,230
Tax-paid	22,150,969	24,344,306	2,193,337
Tax-free, total	179,580,529	227,476,422	47,895,893
For denaturation [2]	175,644,641	223,321,704	47,677,063
For hospital and scientific use	1,931,695	2,033,903	102,208
For use of U. S. and subdivisions	1,057,712	1,224,504	166,792
For export	198,396	196,284	2,112*
For medicinal, beverage and other authorized uses in Puerto Rico	748,085	700,027	48,058*
Losses in warehouses	496,086	496,294	208
Losses in transit	38,188	42,813	4,625
Stocks in bonded warehouses June 30 [3]	30,860,351	21,798,554	9,061,797*
Materials used			
Molasses, gal	158,908,347	194,601,378	35,693,031
Grain:			
Corn, lb	156,650,225	136,815,670	19,834,555*
Malt, lb	21,131,972	16,851,377	4,280,595*
Rye, lb	2,398,507	4,460,927	2,062,420
Other, lb	157,836	63,652 [4]	94,184*
Ethyl sulphate, gal	35,388,995	45,785,850	10,396,855
Sulphite liquor, gal	24,949,950	10,379,740	14,570,210
Pineapple juice, gal	1,593,687	3,255,920	1,662,233
Crude alcohols mixture, gal	1,227,112	3,419,737	2,192,625
Potatoes, lb	743,411	703,010	40,401*
Cellulose pulp and chemical mixtures, lb	149,024	10,124,665	9,975,641
Corn sugar byproduct, lb	130,605	1,205,271	1,074,666
Potato residue, lb	....	371,823	371,823

[1] Includes 1 experimental plant in 1939 and 2 in 1940.
[2] Includes 806,927 proof gallons in 1939 and 728,923 proof gallons in 1940 transferred to denaturing plants by alcohol plants not having bonded warehouses.
[3] Stocks in transit between bonded warehouses and quantities in receiving tanks of alcohol plants awaiting transfer to bonded warehouses not computed.
[4] Includes 21,759 pounds of diamalt.
* Decrease.

year kept the market in an active stage. Production difficulties also added to the market stability by holding outputs in check. An explosion occurred at one fermentation plant and fermentation troubles also were encountered. One of the newest producers likewise is said to have found trouble in operating and the moderate drop in consuming demand was largely offset by a similar action in the production end. When demand for methanol reached its peak, one of the producers of synthetic solvents changed its process with result that it was no longer able to supply its largest customer. This forced the customer to purchase normal butyl alcohol and acetate which he had formerly used only in a small way. This extra demand, which incidentally was increased during the year, taxed producing facilities and another synthetic producer converted a considerable amount of ethyl alcohol into normal butyl alcohol, which accounts, in part, for the abnormal increase in production of ethyl alcohol.

Late in the year it was announced that prices for butyl alcohol and acetate would be advanced for 1941 delivery and this brought a rush of buyers to anticipate the advance which had the effect of holding stocks at a low level as the year closed. However production is going along at an unbroken level and is expected to be in line with consuming demands.

Operations of denaturing plants

	1939	1940
	(Quantities in wine gals.[2])	
Denaturing plants [1]		
Number operated [3]	38	40
Production, total	100,740,510	126,761,830
Completely denatured	17,179,433	15,352,033
Specially denatured	83,561,077	111,409,797
Withdrawals, total	99,872,629	127,004,722
Completely denatured	17,204,615	15,495,290
Specially denatured	82,668,014	111,509,432
Losses, total	100,071	91,695
Stocks June 30, total	1,981,559	1,662,472
Completely denatured	655,996	498,982
Specially denatured	1,325,563	1,163,490
Bonded dealers in specially denatured alcohol		
Number operating	55	52
Received [4]	3,243,249	3,441,108
Removed [4]	3,143,007	3,434,797
Losses in storeroom	1,937	2,756
Stocks June 30	378,009	381,655
Manufacturers using specially denatured alcohol		
Number operating	4,405	4,283
Received	82,417,391	111,342,945
Recovered after use	61,248,937	69,046,201
Total used [5]	142,969,775	177,333,764
Losses	62,761	104,043
Stocks June 30	3,162,641	5,974,138

[1] Including denatured rum.
[2] In wine gallons of approximately 180 proof. A wine gallon is a standard U. S. gallon of 231 cubic inches.
[3] Includes 1 denaturing plant operated in conjunction with experimental alcohol plant in 1939.
[4] Excluding inter-dealer shipments.
[5] Including amount recovered and reused.

The confusion in the general solvents market in the latter part of the year opened further markets for secondary butyl products and both suppliers disposed of such quantities as they cared to market. Amyl producers were in a sold-up position throughout the year.

Sales of methyl ketone increased in 1940 in about the same proportion as 1939 had advanced over 1938. Prices were firm throughout. Part of the demand was due to new uses developed for methyl ethyl ketone and the fact that as the increased demand for acetone consumed large amounts of isopropyl alcohol, both isopropyl acetate producers curtailed operations substantially as compared with 1939.

Production of Methanol

	Production (gallons)	
	Synthetic	Crude [1]
1940		
January	3,452,677	457,271
February	3,782,402	446,815
March	3,462,946	506,937
April	3,486,233	441,888
May	3,408,517	436,883
June	3,426,100	425,578
July	3,851,669	390,004
August	3,787,794	407,764
September	3,548,808	365,786
October	4,408,026	463,165
November	4,439,905	467,976
December	3,913,370	483,953
Total	44,968,447	5,294,020
1939		
January	2,462,884	351,814
February	2,267,339	336,157
March	2,406,564	364,500
April	2,276,385	389,423
May	1,778,581	354,415
June	2,295,288	343,992
July	2,495,394	377,755
August	2,678,983	359,594
September	2,639,934	404,876
October	4,158,161	463,420
November	4,611,707	479,622
December	4,184,479	434,021
Total	34,255,699	4,659,589
1938		
January	2,896,894	458,347
February	2,290,609	408,930
March	2,343,828	432,800
April	1,975,999	314,664
May	1,860,400	330,875
June	1,629,570	293,091
July	1,449,607	309,219
August	1,897,847	281,988
September	1,929,655	303,225
October	2,294,532	335,380
November	2,617,979	344,328
December	2,844,249	357,249
Total	26,031,169	4,170,096

[1] The refined equivalent would be approximately 85 percent of the crude production.

While the general solvent situation may vary from month to month and it is hazardous to forecast a 12-month progress, it seems safe to say that as most solvents are used to some extent and, in some cases are vital, in military operations, demand for these products in the current year will continue to broaden. In addition to domestic requirements, many products consuming solvents are now being made for the British Government which obviously places a strain on existing capacities. There is also quite a large demand for export which, up to the present, producers for the most part have been unable to fill. Most solvent producers find themselves in the dilemma of making a reasonable profit on those products which can be turned out with existing facilities. Construction costs and difficulty in obtaining necessary equipment do not encourage new plant construction. If the preparedness program and aid-to-Britain plans gather momentum, demand for solvents should exceed present production capacities and considerable dexterity will be required by all managements to meet demands with present plants. Such a condition might lead to panic buying and might be considered a just cause for the inauguration of priorities. However, if the programs are well coordinated, the balance between supply and demand may be maintained by full utilization of present facilities.

WOOD CHEMICALS

PRODUCTION of charcoal and wood chemicals from hardwood in 1940 was approximately 20 percent greater than during the preceding year. This was far from a record, but decidedly more output than in almost any year of the past decade except in 1937.

At the end of 1940 the industry was operating at substantially full capacity. Despite this fact, serious shortage of charcoal existed at intervals during the fall and early winter. Several shifts in production methods and uses are now being noted. Some production of hardwood charcoal without byproduct recovery is one such development which several have recommended and one firm is reported to be undertaking. Substitutes for charcoal in some of the major industrial uses is being attempted to reduce the pressure on the limited supplies. The demand for acetic acid and methanol, the two major wood chemicals produced with the charcoal, is very great; but this demand is met principally by the adequate supplies of synthetic materials. There is no pressure for more hardwood distillation simply to give these wood chemicals.

During 1940, more than 540,000 cords of hardwood were processed with the following production: Charcoal at 50 bu. per cord, about 27,-

000,000 bu.; crude methanol, at 10.25 gal. per cord, 5,500,000 gal.; pure methanol equivalent of this production, 4,500,000 gal.; acetic acid equivalent of various chemicals, at 115 lb. per cord, 62 million pounds. This production of acetic acid represents the direct recovery of that chemical plus the acid equivalent of the acetate of lime made, plus the acid equivalent of various other chemicals, principally sodium and ethyl acetate.

It appears that during 1941 the above typical yields will probably be obtained on the average by the industry, which has an installed capacity of approximately 2,400 cords of wood per day. The industry rarely is able to operate at anything approaching rated capacity for the entire year, even when demand is good. Hence, it is expected that not much over 600,000 cords of hardwood will be processed in 1941, or about 10 or 12 percent above the 1940 total. Of the total charcoal made, about 50 bu. per cord carbonized, there will probably be about 48 bu. per cord available for sale, principally in lump form. About 2 bu. per cord of the primary production is made as fine sizes at certain plants which have no market for that material, or represents waste, breakage, and blow-away during preparation and shipment. Two plants still continue to market most of their charcoal as briquets, principally to supply the requirements for dining car and hotel grill uses.

SYNTHETIC ORGANIC CHEMICALS

Heavy exports and new plant construction were the outstanding developments in the synthetic organic chemicals industry in 1940. Exports were not confined to South America but went to German and English customers all over the world. Plant construction was particularly active in synthetic rubber and butadiene. New production peaks were reached in acetic acid as well as for all synthetic organic chemicals.

NEW PLANT construction is the biggest thing the synthetic organic chemicals industry has to report for the year 1940. Production was up probably 20 percent or more from 1939 levels (see *Chem. & Met.*, June 1940, p. 437 for 1939 statistics), but such increases have come to mean only "normal growth" to men in the industry. The increase in production capacity, however, was more than normal. Indications for 1941 are that the trend will continue, and it will be largely independent of the National Defense Program.

Of course, the most interest in new construction has centered around synthetic rubber and its raw materials. A shroud of mystery has surrounded the whole development because the National Defense Commission has not made its position known. However, the problem is now up for decision and the situation should become clarified soon, perhaps even before this issue of *Chem. & Met.* reaches the reader.

Standard Oil Co. of Louisiana has been working on a $2,800,000 plant to make the buna-type synthetic at Baton Rouge. This five-ton-a-day plant has been delayed in construction but will be ready to operate by Spring. Firestone was making Perbunan on a commercial scale at Akron by April of last year under license from Standard Oil. Butyl rubber, a polymer of butadiene and butene, was announced by Standard Oil Development Co. but was not commercialized in 1940.

In June Ameripol, a butadiene synthetic, was announced by the B. F. Goodrich Co. Later the Hydrocarbon Chemical & Rubber Co. was formed by Goodrich and Phillips Petroleum Co. to make the crude synthetic under the name Hycar. Three plant units for production of this material were built at Akron in 1940 and their capacity amounts to several tons per day. Goodrich also built a new plant to make Koroseal at Niagara Falls, N. Y.

In August Goodyear announced that its butadiene polymer, Chemigum, was in semi-commercial production and that a five-ton-a-day plant was being installed in existing buildings. Later (November) it was announced that a new plant was being built in Akron to increase production 300 per cent and employ 75 men. The plant was to be finished in six months.

New construction for neoprene was announced by du Pont during the year which, when completed in the Fall of 1941, will bring the Deepwater, N. J. plant's annual capacity to 9,000 tons.

BUTADIENE

All the newer synthetic rubbers require butadiene; so a number of companies are building new capacity at top speed. Dow Chemical Co. was the only producer listed (U.S.T.C.) in 1939, but when the rubber companies wanted more of the chemical and quickly, Shell Development Co. took a laboratory process off the shelf and put it into pilot plant operation. The pilot plant has been producing more than 1,000 lb. a day, but Shell is hastily building a 15-ton-a-day plant at Houston, Tex., to provide for the expanding demand. The new plant will be ready before the middle of the year. Meanwhile Dow is endeavoring to increase production with another process now in the pilot plant stage.

Phillips is building a plant to supply butadiene for Hycar as a byproduct of its neohexane process at Borger, Tex. The plant will be finished shortly. Standard Oil, too, is providing itself with a supply of butadiene by building a plant which will be ready to operate in April or May.

Carbide and Carbon Chemical Corp. is making some butadiene now at South Charleston, W. Va., and will be equipped to make more at Texas City, Texas. Whether the Texas plant actually produces this material will depend on developments in synthetic rubber.

The other big tonnage raw material for the synthetic rubbers is acrylonitrile. American Cyanamid & Chemical Co. started operating the first large-scale plant to make this material on July 1, 1940. It's capacity was doubled before the end of the year. It is understood that Dow Chemical Co. also built an acrylonitrile plant, but details are lacking.

TOLUOL AND PHENOL

Toluol was made from petroleum on a large scale for the first time in 1940. Though not a synthetic chemical in the strict sense because it is made so far only by extraction from crude oil fractions, it is still of interest in these columns because it indicates a trend. When Shell Oil Co. started operating its 2,000,000 gal. per year toluol plant at Houston in December, plans were already under way for a much larger plant at the

Humble Oil refinery almost next door in Baytown, Tex. The plant is being built with Government money as a part of the Defense Program and will cost $11,857,000. Shell's plant was understood to have cost about $500,000.

Phenol productive capacity was greatly increased. Durez Plastics & Chemicals, Inc. brought into operation after two years of construction, a 15,000,000 lb. per year plant at North Tonawanda, N. Y. The plant cost $2,000,000 and utilizes a vapor phase regenerative process invented in Germany (see *Chem. & Met.* for November, pp. 770–775). Another synthetic phenol plant was put in operation by The Barrett Co. at its Frankfort, Pa. works. Calco Chemical Division of American Cyanamid installed at Bound Brook, N. J., an additional tar acid still unit to provide an increased supply of naphthalene, anthracene and phenol.

OTHER CHEMICALS

The year 1940 was a big construction year for Carbide & Carbon Chemicals Corp. and Dow Chemical inasmuch as both companies started the building of large plants in Texas. Carbide's plant at Texas City is to be much like the plant at Whiting, Ind., making a long line of aliphatic chemicals from refinery gases. The Dow plant will make primarily metallic magnesium and bromine from sea water; however, a third unit started late in the fall, will make ethylene and various hydrocarbon derivatives.

Among the new resins produced for the first time during the year were Dow's Saran and American Cyanamid's Melamine. Cyanamid is also building a new resin plant at Wallingford, Conn. Significant new products introduced by Carbide & Carbon Chemicals Corp. included ethyl hexanol, maleic anhydride and the Carbowaxes.

The big expansion in nylon (see Synthetic Fibers) required a corresponding expansion in the facilities for making nylon intermediates at Belle, W. Va. Also at Belle, the duPont company started production during 1940 of ethylene glycol, which appeared on the anti-freeze market under the trade name Zerex.

In addition to starting its new acetic acid plant at Peoria, Ill., in January, 1940, Commercial Solvents Corp. finally started operating in early summer its new plant units for the production of nitroparaffins. The basic NP's produced first were nitromethane, nitroethane, 1-nitropropane, and 2-nitropropane, but a long list of derivatives also is being produced. Early in the year the company started operating a plant to make riboflavin (Vitamin G) on a large scale. The vitamin is being used on a tonnage basis to restore potency to wheat flour and in animal foodstuffs.

Monsanto Chemical Co. figured in the new construction to a considerable extent. At Norfolk, Va., a new plant was built to make theobromine from cocoa byproducts. At St. Louis new facilities now produce a phenolic acid salt used as an addition agent for crankcase oil. Also a plant was built to make diphenyl phthalate. At Nitro, W. Va., a new rubber accelerator is in production as is thiourea. (American Cyanamid also produced thiourea on a plant scale for the first time.)

Monsanto's expansion also included substantial increases in production capacity for nitration of chlorobenzol and catalytic hydrogenation at Monsanto, Ill. The latter process produces cyclohexylamine and p-aminodiphenyl. At St. Louis, the plant for production of sulphanilamide and its intermediates was materially expanded.

FOREIGN TRADE

As expected, there was a good bit of shifting in international trade during the year. Imports again declined and exports were up. Exports of dyes were particularly heavy, almost reaching the 25 million lb. mark as compared with 13.7 million lb. in 1939. Imports of dyes dropped off from 5 to about 2 million lb. Thus domestic production had to take up slack both ways and thereby was increased an estimated 22 percent over 1939, though textiles production was up only 8 percent.

It was necessary to produce in this country some items that had formerly been imported (such as potassium ferricyanide and other potash salts) but such production did not run into large quantities. In fact, chemical industry was better prepared for the new situation than had been suspected; so the transition was comparatively easy.

ACETIC ACID

A JUMP in cellulose acetate rayon production, together with sizable increases in lacquer solvent requirements, was largely responsible for raising the consumption of acetic acid some 30 million pounds in 1940 over 1939. All cellulose acetate production (including film and sheets, rods, tubes and molding compounds), was estimated at 175,000,000 lb. in 1940 as compared with 125,000,000 lb. in 1939. Amyl, butyl and ethyl acetate production probably also reached a total of 175,000,000 lb. as compared with 150,000,000 for 1939. Textile production was up slightly—about 8 percent.

All these increases meant increased consumption of acetic acid, but not necessarily in proportion. There seems to be a trend toward replacement of acetic by other organic acids in some uses. For instance, propionic and butyric acids are now used in increasing quantities in cellulose acetate plastics. Formic acid has replaced a considerable amount of acetic that was formerly used in textile dyeing and in coagulation of rubber latex. Large quantities of formic acid were shipped to the East Indies and though du Pont's and Victor's plants were operating at capacity they were unable to supply the demand. This situation has arisen since 1938, and the consumption of formic acid has been more than doubled since that time.

Acetic acid, too, was exported in larger quantities than ever before. With Germany and England at war, and unable to supply their normal customers, and Japan using all her own production, the United States and Canada supplied needs all over the world. Butyl acetate exports were about as usual, but exports of glacial acetic jumped from 2,000,000 to 6,000,000 lb. Substantial quantities (about 200 tons) of acetic anhydride were exported from the United States for the first time. Shawinigan Chemicals, Ltd., in Canada, supplied more of the new export trade for acids than did any of the United States producers.

Production statistics on acetic acid and derivatives are meager, partial, and in many cases unreliable. The reason for this situation is that there are so many ways in which these compounds are made and used that it is difficult to get a statistical pattern without duplication. The only official data that have properly accounted for such duplication are included in a report published by the U. S. Tariff Commission on June 4, 1938. All the data in that report have previously been published in *Chem. & Met.*, and, in addition, *Chem. & Met.* editors have endeavored to make estimates bringing that information up to date in subsequent years. To eliminate duplication it is necessary to add to the actual pri-

mary production of acetic acid the production of ethyl and sodium acetate made direct without going through the acetic acid stage and the production of acetic anhydride which is not made from acetic acid.

Adding all these together and converting them to a common base of 100 percent acetic acid, production and consumption data become really indicative of the activity in the industry. *Chem. & Met.* estimates, prepared on this basis, will be given in the following paragraph. Then an attempt will be made to explain the complex situation that makes these estimates only guesses.

Domestic consumption of acetic acid and derivatives reached an all-time high in 1940 of about 252,000,000 lb., of which 2,000,000 lb. was imported. Thus, production for domestic consumption was 250,000,000 lb., and an additional 10,000,000 lb. was produced for export. Production was divided between various sources as follows: Direct recovery from hardwood distillation and manufacture from acetate of lime accounted for 62,000,000 lb. Synthesis, fermentation and other methods made up 198,000,000 lb.

Prior to 1926 all acetic acid produced in the United States was made from acetate of lime, which in turn was procured from hardwood distillation. However, the increased demand in the early twenties brought about by lacquer requirements in the fast-growing automobile industry provided an incentive for development of synthetic and fermentation methods. Synthetic acetic acid was first reported in 1928, and its production has grown by leaps and bounds ever since.

In an effort to meet this new competition the wood distillation industry developed methods of recovering acetic acid directly from the pyroligneous liquors without making acetate of lime. This is helping the industry to maintain sales at about the same order of magnitude from year to year, but synthetic acid is taking all the new business.

Chem. & Met. Estimates for U. S. Acetic Acid and Derivatives

(Millions of pounds, basis 100% acetic acid)

	1937	1938	1939	1940
Production......	177	157	227*	260
Imports........	32	6	2	2
Exports........	3	3	6	10
Consumption....	206	160	223*	252

*Revised.

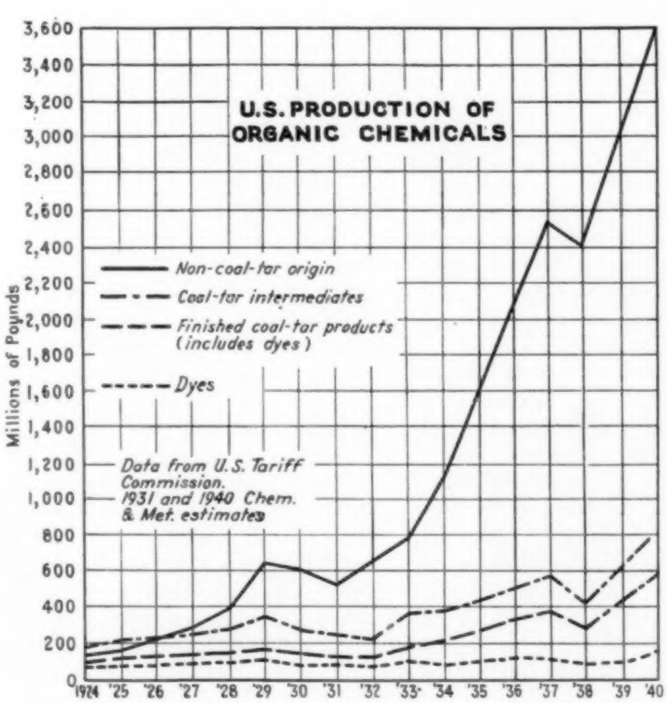
Conversion of acetate of lime to acetic acid is still carried out by two large chemical companies, Monsanto and General Chemical. The latter company is understood to be buying for resale both synthetic and direct recovery acid to supplement its own production.

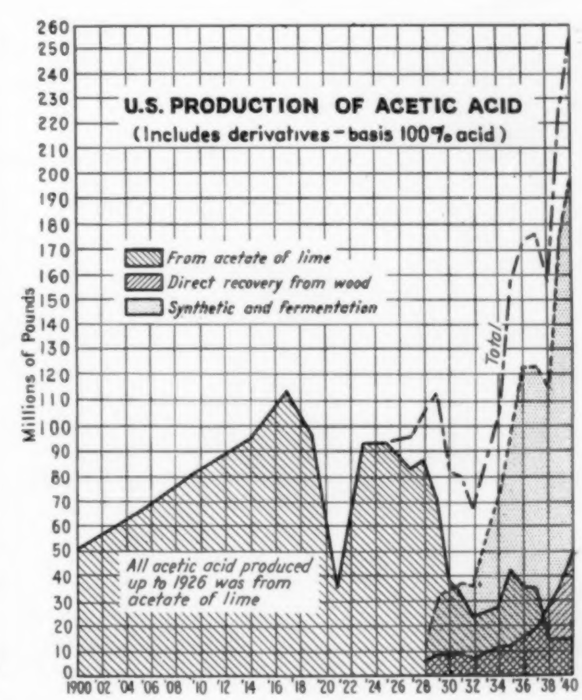
There are now 12 direct recovery hardwood distillation plants with a combined capacity of about 1,400 cords per day. There are 20 acetate of lime distillers with a combined capacity of about 900 cords. A large distillery at Iron Mountain, Mich., owned by the Ford Motor Co., produces ethyl acetate direct. In addition, there is a small chemical company still using the sodium acetate process.

Newberry Lumber & Chemical Co. was the last plant to change over from acetate of lime to direct recovery, and it did not get into full production until 1940.

With the advent of large-scale cellulose acetate rayon production in the thirties, acetic anhydride entered the picture further to complicate the market situation. Cellulose acetate (including film and plastics) is now nearly as large a consumer of acetic acid as lacquer solvents. But much of that acid is consumed in the form of anhydride; so several cellulose acetate companies have decided to make their own anhydride and two of them make their own acid. It is generally known that the rayon process requires a much larger quantity of acid in processing than is actually consumed. H. D. Smith, of A. M. Tenney Associates, Inc., states that 6 lb. of glacial acetic acid and 2.4 lb. of acetic anhydride are needed per pound of yarn made. But all of this is recovered and used again except 0.54 lb. of 100 percent acid. In general, wood acid is not satisfactory for use in rayon.

Just as synthetic acid and anhydride have outdistanced all other acetic acid production, Niacet Chemical Co. and Carbide & Carbon Chemicals Corp. have out-distanced all other producers. Niacet produces practically all the synthetic acid





made for sale in the United States. It is made from acetylene which in turn is made from carbide at the Niagara Falls plant.

Carbide & Carbon Chemicals Corp. makes large quantities of acetic acid, but it is all used in the company's plants to make solvents, vinyl acetate plastics and acetic anhydride. Carbide is the only large seller of anhydride and makes it at South Charlestown, W. Va., and Whiting, Ind., from acetic acid and ketene by a novel process. Most of its output goes into the manufacture of rayon, but substantial quantities are used to make aspirin and other chemicals. Carbide's new plant at Texas City, Texas, will also make anhydride.

E. I. du Pont de Nemours & Co. is both a producer and consumer of both acetic acid and anhydride. The anhydride is made from acetic acid and acetylene at the company's acetate rayon plant at Waynesboro, Va. A new plant to make acetic acid by inserting a ketone group into methyl alcohol has been built at Belle, W. Va. The plant did not come into full production until May, 1940, but it now supplies all the company's requirements plus several customers who have been buying from Grasselli for years. Du Pont once made acid from acetate of lime, but has not done so for several years. Since then, Niacet supplied the company's needs until the new plant was built.

Tennessee Eastman Corp., at Kingsport, Tenn., has a wood distillation plant of about 140 cords daily capacity. Acetic anhydride was formerly made there from sodium acetate obtained from the pyroligneous liquor. But in 1936 the plant was changed to direct recovery. Synthetic acetic acid is also made by the company from ethyl alcohol in a plant constructed recently. Some of this acid is converted to anhydride by a pyrolytic process. T-E can supply most of its requirements for cellulose acetate rayon, plastics and film, but buys some acid when running at full capacity. At other times the company offers acetic acid and possibly some anhydride for sale.

Celanese Corp. of America, largest manufacturer of acetate rayon, makes anhydride from acetic acid recovered in the rayon process. The company has no original source of acetyl radical, however, so must buy either anhydride or acid. A few years ago this make-up acid was purchased from Shawinigan Chemicals, Ltd., in Canada, but this business was switched to domestic producers in 1938, causing a tremendous decline in imports. A small amount of acid was again imported in 1940, however. The Celanese plant is located at Amcelle, Md.

In addition to du Pont and Celanese, there are two other large acetate rayon plants—the Meadville, Pa., plant of American Viscose Corp., and the Rome, Ga., plant of Tubize Chatillon Corp. Neither of these companies is a producer of either acetic acid or anhydride.

So much for the acetic acid made for consumption in cellulose acetate.

Besides du Pont and Carbide, two other solvents manufacturers make their own acetic. U. S. Industrial Chemicals Co. makes the acid by the classic beechwood fermentation process and consumes most of its own production in making solvents at its Baltimore plant.

Commercial Solvents Corp. makes part of its acetic acid requirements from ethyl alcohol by a new process. Two new plants have been built—one at Agnew, Calif., and the other at Peoria, Ill. The Peoria plant, larger of the two, went into operation early in 1940. The company still purchases acid, however.

With a 30-million-lb. increase in consumption during 1940, it stands to reason that business was good. But that condition did not exist the year round. The first six months were slow, but acid sales picked up in the summer and were strong in the fall. Then 1941 started off with a bang. Although there is no actual shortage of acid, the market is extremely active. How good a year 1941 will be cannot be predicted, but the National Defense program is not expected to provide much stimulating effect. Textiles consumption will be high until the soldiers are completely outfitted, but the mills are doing a pretty good job of keeping abreast of orders; so that business may not hold throughout the year. Production of automobiles will probably have to give way to tanks, trucks and planes, reducing lacquer consumption with a consequent reduction in acetate requirements. So, the outcome of 1941 will depend on the balancing effect of these offsetting factors.

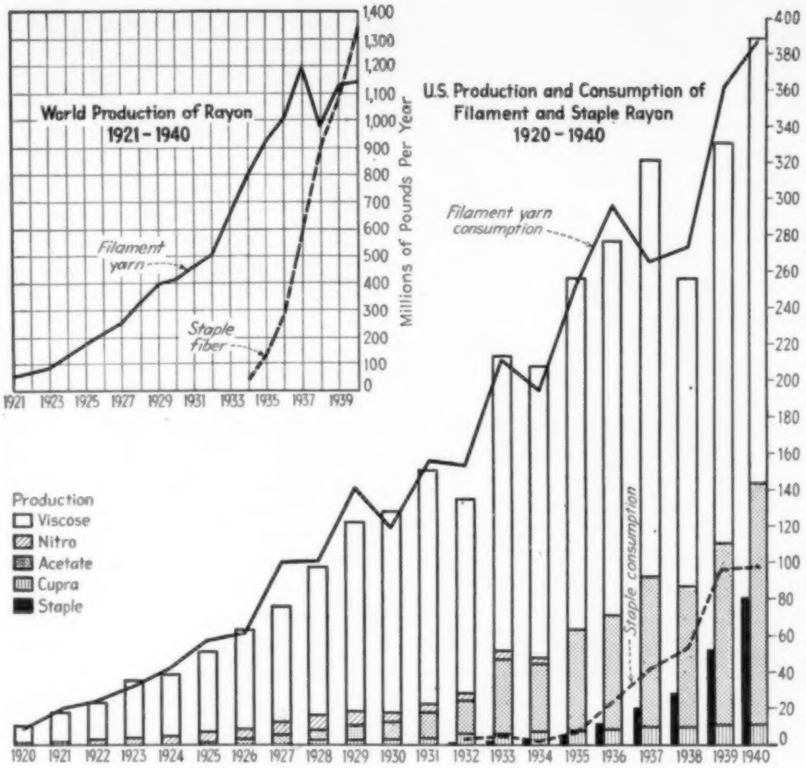
RAYON AND SYNTHETIC FIBERS

Increases of 19 per cent in filament yarns and 58 per cent in staple production were the record of the United States rayon industry in 1940, compared with 1939, the best previous year. Consumption of filament yarns increased by 6 per cent, while staple use, owing to a shortage of imports, remained about as in the earlier year. For the first time, non-cellulose-derived synthetic fibers became commercial factors.

ADDING to its already long list of epic achievements, the synthetic fiber industry again surpassed all previous records throughout the world. In the totalitarian countries, the new high levels were forced by economic necessity, but in the United States rayon and other synthetics continued their normal inroads into the fields of other fibers, purely on their merits and entirely without artificial aids.

As has been the case for several years past, the official statistics of the rayon industry were collected and reported by the *Rayon Organon* which announced filament yarn production in 1940 to have been 390,072,000 lb., an increase of nearly 19 percent over the 1939 production of 328,625,000 lb. Consumption was slightly less, about 388,729,000 lb. Staple fiber production increased 58 percent, from the 51,374,000 lb. reported in 1939, to a total of 81,098,000 lb. in 1940. Staple imports were off sharply, however, from 47,403,000 lb. in 1939, to an estimated 18,000,000 lb. in 1940, so that the staple available to consumers in 1940, namely 99,100,000 lb., was barely larger than that in 1939. Nevertheless, the rapid increase in staple production which has taken place in the last five years suggests that the end of the expansion of this material is by no means in sight.

In the United States, staple is not used as a wool substitute, but rather for the novel effects and special characteristics it can produce. Elsewhere, however, especially in the totalitarian countries, this situation does not obtain, which accounts for the sharp increase registered in world staple output, compared with filament yarn production. In 1940 world filament



yarn production is estimated by the *Rayon Organon* to have increased slightly, to the total of 1,150,000,000 lb. Staple, however, reached the level of 1,350,000,000 lb., an increase of 25 percent over the production of the preceding year.

Rayon Production and Imports 1921-1940

	Thousands of Pounds		
	U. S.* Production	U. S.† Import Balance	World* Production
1921......	18,000	3,276	65,000
1922......	26,000	2,116	80,000
1923......	35,000	3,029	97,000
1924......	38,750	1,954	141,000
1925......	52,200	5,293	185,000
1926......	62,575	8,945	219,000
1927......	75,050	14,633	267,000
1928......	97,700	11,948	345,000
1929......	121,399†	14,832	404,000
1930......	127,333†	5,995	417,000
1931......	150,879†	1,490	470,000
1932......	134,670†	−456	509,000
1933......	213,498†	−176	660,000
1934......	208,321†	−2,432	799,589
1935......	257,557†	−2,193	932,780
1936......	277,626†	−1,558	1,022,000†
1937......	321,681†	−525	1,199,000†
1938......	257,916†	−1,195	990,000†
1939......	331,200†	−1,703	1,145,000†
1940......	390,072†	−1,485	1,150,000†

* From *Textile World* except as noted: does not include staple.

† From *Rayon Organon*. Does not include staple which is estimated at 350,000 lb. in 1930; 880,000 lb. in 1931; 1,100,000 lb. in 1932; 2,100,000 lb. in 1933; 2,200,000 lb. in 1934; 4,600,000 lb. in 1935; 12,300,000 lb. in 1936; 20,244,000 in 1937; 29,861,000 lb. in 1938; 53,000,000 lb. in 1939; and 81,098,000 lb. in 1940. World staple estimated at 6,100,000 lb. in 1930; 52,700,000 in 1934; 139,900,000 lb. in 1935; 299,000,000 lb. in 1936; 619,000,000 lb. in 1937; 958,000,000 lb. in 1938; 1,025,000,000 lb. in 1939; and 1,350,000 lb. in 1940. Import balance does not include staple: minus sign indicates net exports; staple imports 12,721,000 lb. in 1936; 20,614,000 lb. in 1937; 23,197,000 lb. in 1938; 47,403,000 lb. in 1939; and 18,000,000 lb. (est.) in 1940.

The United States production of filament yarns in 1940 is stated to have consisted of 257,124,000 lb. of viscose plus cuprammonium (of which we estimate that 11-, 12,000,000 lb. was cupra), plus 132,947,000 lb. of acetate. Thus acetate now accounts for slightly over one-third of the filament yarn capacity of the industry, compared with its less than 8 percent of only ten years ago. The entire industry operated at capacity for the year and would doubtless have set an even higher level if considerable production time had not been lost through floods and labor disturbances. As of November 1940, *Rayon Organon* estimated the industry's conservative operating capacity to be 395,000,000 lb. of filament yarns, with 110,000,000 lb. of staple. By March 1942 the corresponding figures are expected to be 430,000,000 lb. of filament yarns and 145,000,000 lb. of staple.

OTHER SYNTHETICS

A year ago we reported on the status of non-cellulose synthetic fibers which were just then beginning to attract a great deal of attention. The situation then portrayed has now advanced toward commercialization. Du Pont's nylon capacity, at the original Seaford, Del., plant and at the new Martinsville, Va., plant is in the process of expansion to a total of 16,000,000 lb. capacity. American Viscose's Vinyon yarn is now entering the apparel field, in addition to the industrial applications previously developed. National Dairy Products' Aratex Division is in commercial production on milk casein fiber which is going into felt hats and automotive upholstery. Experimental production has been realized on milk casein fiber by the Borden Co. and on soybean protein by the Glidden Co. and the Ford Motor Co. Strong rayons of the various cellulose-base types are also gaining in interest. Strong viscose filaments are already in considerable use for tire cords and are shortly to be offered for hosiery. Comparable cellulose acetate products have been developed and may be commercially available in a short time.

OILS AND FATS

Domestic production of fats and oils in 1940 is estimated at 8.8 billion lb. This figure exceeds the 1939 previous all-time record by nearly 600 million lb. Lard, linseed oil, soybean oil, and inedible tallow and greases were responsible for most of the increase. Domestic tung oil, although a small percentage of the total, also set a new high.

A NEW RECORD for domestic production of fats and oils was established and notable progress was made in fats and oils technology during this year 1940. Outstanding chemical engineering achievements were made in soap manufacture, in paint and drying oil production and in edible oil technology. Each of these deserves much more elaboration than can be given in such a brief report as this, so frequent references to literature will be made.

Soap—Outstanding soap development of 1940 was the opening of the new Procter and Gamble plant at Quincy, Mass. Here for the first time is a complete soap plant with-

out the traditional soap kettles. The continuous saponification process for which the plant is designed has been mentioned previously,[1,2,3] but opening of the plant last fall marked the end of development scale operations and the beginning of full-plant-scale production.

The Clayton process for continuous saponification, briefly described in a recent issue of *Chem. & Met.*,[3] is also said to be operating now at a number of soap plants.[3] This process has been described in considerable detail by one of the men responsible for its development.[4]

Synthetic glycerine made from petroleum is now available on the market in limited quantities, as a result of successful operation of the Shell company's pilot plant. This process[5] and the fermentation process used in the last World War certainly assure a stable price and unlimited supply of glycerine for the future, without dependence on the soap manufacturer.

Drying Oils—Another conspicuous example of chemical engineering progress in fats and oils was the 1940 announcement[6] that new synthetic drying oils are now available, made by Armour and Co. from domestic sources. The process, anticipated in last year's review, is based on the fractional distillation of the fatty acids obtained from fish oil or soybean oil or any other semi-drying oil. The desired unsaturated fatty acid fractions are then re-combined with glycerine to make oils with properties comparable to linseed and tung oils.

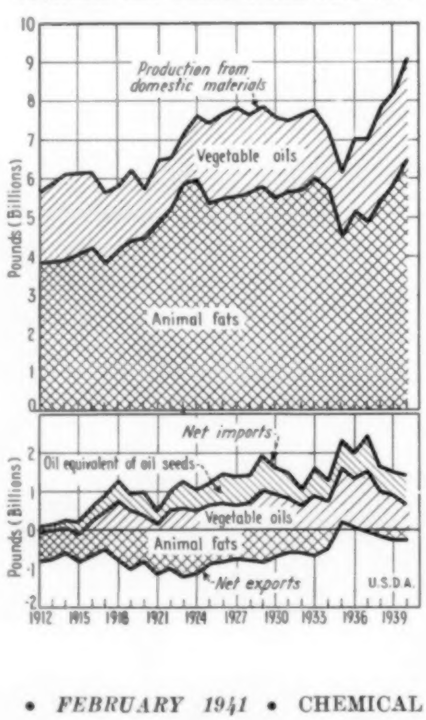
The fatty acids themselves are, of course, also available as a result of this fractional distillation process. Tank car lots of both the saturated and the unsaturated fatty acids are now being sold in commercially pure state and at a cost very little different from the ordinary distilled fatty acids. This amounts to two to four times the basic oil cost, or in present market conditions, 10 or 15 cents a pound.[8] In addition to the usual saturated fatty acids (caprylic to stearic) the relatively rare arachidic and behenic acids may also be commercially available in the near future, by hydrogenation of the corresponding long chain unsaturated acids.

Foreshadowed as a comparable development of 1941 is the selective solvent extraction process for separating the drying and non-drying fractions of semi-drying oils.[7] This process is based on separation of the oils rather than the constituent fatty acids. However, the separation is limited somewhat by the fact that different fatty acids are usually combined in the same oil molecule. When a drying oil fatty acid (unsaturated) and a non-drying oil fatty acid (saturated) are combined in one oil molecule, the drying characteristics of that molecule would be about the same as those of the original oil. No solvent extraction method could be expected to change them. However, by splitting the molecules into fatty acids and glycerine, the fatty acids can be separated by a selective solvent and then re-combined with the glycerine to make new oils of the desired chemical or drying characteristics. It would then be only a modification of the Armour fractional distillation process, substituting solvent separation for distillation. It is for this reason, presumably, that Armour splits the oil before applying the fractionating process.

The introduction of a solvent extraction process into fatty acid manufacture is an interesting development now in the rumor stage. One of the leading companies in this field is said to be working on such a process, but no announcements had been made up to the first of the year.

A tung oil substitute was announced late in 1940 by Paraffin Companies, Inc. Although the name of the company implies that it is based on a petroleum raw material, it is not unlikely that the new product may be a fish oil derivative. Rumors have also come from the Pacific Coast that a process of freezing the saturated fats out of a semi-drying oil is being perfected. It may be that these are two ends of the same string. However, no technical details have yet been announced regarding the composition or manufacture of the tung oil substitute.

Production and trade in animal fats and vegetable oils, United States, 1912–1940



Ideal solution to the domestic drying oil scarcity problem would be the development of a process which permits dehydrogenation of an oil as readily as hydrogenation now may be achieved. When this is practicable, our dependence on imported natural drying oils will be virtually ended.

Edible Oils—With the Mediterranean a battlefield since the middle of the year, olive oil imports into the United States have been sharply curtailed. Substitutes for this popular oil have been sought urgently. Tea seed oil has properties closely resembling olive oil and is satisfactory for a number of its uses. As a result, all available stocks have been quickly absorbed. However, the Oriental source of tea seed oil makes this substitute of doubtful strategic value when compared with the source of the material which it is intended to replace.

An interesting development was disclosed with the announcement of a domestic substitute for olive oil.[9] This is an olive-flavored oil produced by infusion of crushed olive meats into a bland corn oil base. The amount of "olive oil" produced by this process is said to be 30 or 40 times the amount which could be produced in the usual manner from the quantity of olives used in the process. Not only are the flavor and the odor remarkably like those of true olive oil, but the keeping quality of the corn oil is considerably extended. Furthermore, much of the olive carotene (pro-Vitamin A), normally left in olive cake residue, is imparted to the oil resulting from the infusion process. Since the resultant infused oil is predominantly corn oil (over 90 percent), the chemical characteristics of this product are practically those of corn oil; but any of a number of oils could be used as a base for such a product if corn oil characteristics should be undesirable for any reason.

The freezing of peanuts prior to crushing is an interesting rumor of another new development. Small scale tests are said to have shown improved oil yields. Here again, however, comparatively little publicity has been given to the technical details of the process or to the quality of the oil compared with that pro-

duced by the old traditional methods.

An announcement of a new copra mill to be built in British Columbia forecasts the loss of a bit of our export market for vegetable oils. The percentage of our coconut oil production lost will scarcely be felt, but the new plant may be a significant factor because it is to be designed so that peanuts and beans may also be crushed if future conditions warrant such expansion.

Discussion is being heard of plans to improve the nutritional qualities of some of the edible fats by various means. Vitamin fortification is suggested by some. Such work as this will be further investigated by the National Research Council committee on food and nutrition. The Food and Drug Administration will still have jurisdiction over permissibility of addition of novel or unusual ingredients, label declaration, and so forth. Any early or large-scale development seems unlikely.

Statistics—A new record was established in 1940 in the production of fats and oils from domestic materials. The tentative estimate of 8.8 billion pounds is over seven percent higher than the corresponding 8.2 billion pounds produced in 1939. Lard, linseed oil, soybean oil, and the inedible tallow and greases were responsible for most of the increase.

Domestic tung oil production was estimated to be 5 million pounds, also a new record, although still a small percentage of the total fats and oils production of the country. This is a 65 percent increase over 1938, the largest preceding crop, the 1939 output having been damaged by severe freezing weather in the Spring of that year.

Although this represents the largest amount of tung oil ever produced in this country, it is still only five percent of the normal domestic consumption. With imports from the Orient now severly curtailed, stocks are being drawn from storage in this country to supply demand. The quality of the domestic tung oil is above that of the average imported oil, but the quantity is far from sufficient to keep the price anywhere near a normal level.

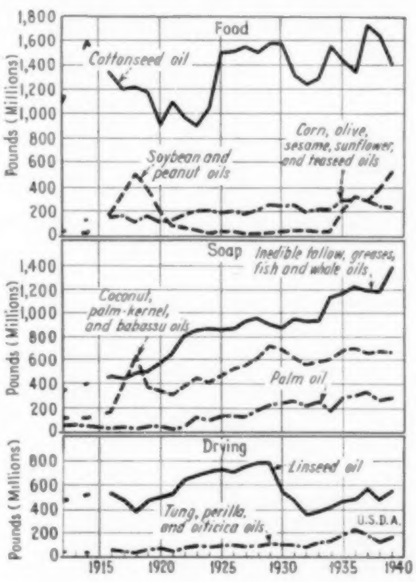
A new record was also established for peanut production, estimated at about 1,600 million pounds. This represents more than a 35 percent increase over the preceding year, and exceeds by far the 1938 production, formerly the largest domestic peanut crop ever produced. A record peanut oil production in 1941 is expected to result.

A number of other crop developments of the year were notable. For example, slightly over 31 million bushels of flax seed, the largest domestic crop in many years, were harvested in 1940. Although the Argentine crop was only about half its normal size, the usual Argentine export markets, except for the United States, are largely cut off by the British blockade. The result is a very large potential supply of linseed oil in the Western Hemisphere.

The castor seed production of Brazil set a new high during the past year, with imports into the United States of this oil-bearing material also at a new record. The dehydrated castor oil which will result from this import, in addition to that from the increasing amounts of domestic seed, will help considerably in relieving the tung oil shortage.

The domestic soybean crop was slightly smaller than in 1939 because of a combination of unfavorable weather factors during the growing season. An interesting phenomenon was observed in the soybean oil produced from the 1940 crop. Much of it was green in color, a condition which was shown by the Soybean Regional Laboratory at Urbana to be due to the unusually high temperatures and lack of rain during the maturing season. A little stronger bleach than normal was found to remove this green coloring, the oil having the usual characteristics otherwise. Despite the smaller crop, the net available stock of beans for crushing in 1941 will be about the same as in 1940 because of loss of export markets for the beans. The 1941 soybean oil production therefore will also be about the same.

Estimated total disappearance of specified fats and oils grouped according to principal uses, United States, 1912–1939



Outlook—With industrial activity in 1941 promising to exceed that of any recent years, domestic demand for fats and oils is expected to be very good in the coming year. Despite the fact that those fats and oils which we normally export have an uncertain future, many fats and oils which we need to import in large quantity may be both scarce and costly. Considering all factors, the fats and oils price index will probably increase slightly on the average during the year ahead.

The long-range price outlook is for lower prices ultimately. This forecast is based on the large increases in world productive capacity in recent years, a factor which may have significant effect even before the war is over. In the meantime, efforts in the United States to substitute oils which are in surplus for oils which are scarce will materially accelerate the technologic advances reported.

[1] Oils and Fats—*Chem. and Met.*, 47, 87 (1940).
[2] Fatty Acid Panorama—*Chem. and Met.*, 47, 830 (1940).
[3] Continuous Soap Making—*Soap*, May 1940, p. 25.
[4] Clayton Continuous Soap Process—*Oil and Soap*, 17, 184 (1940).
[5] Synthetic Glycerine from Petroleum—*Chem. and Met.*, 47, 834 (1940).
[6] New Synthetic Drying Oils from Domestic Sources—*Oil, Paint, and Drug Reporter*, July 22, 1940, p. 3.
[7] Chemical Engineering Advances in Soybean Processing—*Chem. and Met.*, 47, 614 and 694 (1940).
[8] Makes "Olive Oil" from Corn—*Food Industries*, November 1940, p. 49.
[9] Fractional Distillation of Fatty Acids, *Chemical Industries*, 48, 50 (1941).

LEAD AND ZINC PIGMENTS

SALES of lead and zinc pigments in 1940 declined slightly in comparison with 1939, according to the Bureau of Mines. Sales of red lead, white lead, litharge, and zinc oxide declined in 1940, but those of leaded zinc oxide established a high record, and those of sublimed lead increased moderately.

Pigment Sales

	Short tons 1940	Short tons 1939
Basic lead sulphate or sublimed lead	*5,700	*5,538
Red lead	38,400	39,976
Orange mineral	140	131
Litharge	88,300	89,518
White lead —		
Dry	28,300	30,509
In oil†	50,900	67,920
Zinc oxide	112,400	114,552
Leaded zinc oxide	43,000	42,684
Lithopone	146,600	142,759
Zinc sulphate	11,400	10,157

* Exclusive of basic lead sulphate used for the manufacture of leaded zinc oxide which is included in tonnages shown for that pigment.
† Weight of white lead only.

COKE AND BYPRODUCTS

An increase of about 25 percent was registered by last year's production of coke and other coal products. And it is evident the industry will be operated close to its full capacity in 1941. At the end of the year there were operating 85 byproduct plants of which 80 were recovering ammonia, 55 were recovering benzol, 53 were producing toluol, and 27 making naphthalene.

DURING 1940 the production of coke and other coal products increased by approximately 25 percent over the preceding year. The demand for byproduct coke for pig iron manufacture of course occasioned the large increase in output. And, as 1941 begins, it is evident that this demand will continue to press the industry close to its full capacity for production for many months to come.

At the year end the byproduct coke industry was operating at nearly 92 percent of rated capacity which is near to the maximum feasible rate of operation, taking account of minor operating delays, short breakdowns, time required for cleaning and adjustment, and other interruptions. The average operating rate during 1940 was approximately 86 percent rated capacity for all of the byproduct ovens of the country, including those which operated only part of the year or not at all.

The production of coke in 1940 was approximately 53.9 million tons from byproduct ovens and 2.9 million tons from beehive ovens, or a total of 56.8 million tons of coke. The byproduct coke production was an all-time record output, exceeding 1929 by nearly one-half million tons. The yields from the 81 million tons of bituminous coking coal used continued about as usual, near 70 percent for the byproduct ovens and 63 percent for beehive ovens.

At the end of the year there were operating 85 byproduct plants of which 80 were recovering ammonia, 55 were recovering benzol, 53 were producing toluol, and 27 making naphthalene. The official reports of the Bureau of Mines issued late in January indicate the following production of byproducts during 1940:

Gas ....848,000,000 M cu. ft.
Tar ....696,000,000 gal.
Ammonium sulphate 1,434,000,000 lb.
Ammonia liquor (NH_3 content) 57,000,000 lb.
Crude light oil......215,000,000 gal.

By refining of the crude oil above reported, coke plant operators produced byproducts during 1940 as follows: toluol, 25 million gallons; benzol (crude and refined plus motor benzol), 133 million gallons; and naphthalene, 61 million pounds. Toluol was also produced, as were other light oil derivatives, by tar refiners and other secondary producers of the products from coke ovens. Toluol was also made in substantial quantities at several petroleum refineries as a byproduct of aviation gasoline manufacture. At the year end the toluol capacity of the coal products industry was somewhat in excess of 30 million gallons per year. Plants now operating or under construction in the petroleum industry are to have even larger capacity. Much of this new petroleum capacity will be tied in closely with the explosives program of the government, and much of the new capacity is actually government owned or financed.

During 1940 more beehive coke was produced than has been made in any year since 1929 except 1937. Some old beehive ovens that had been practically abandoned were reconditioned and put back into service, especially in Alabama where a serious shortage of coke threatened during the fall. Further use of old beehive ovens is expected in 1941.

At the end of 1940 the stocks of coke in possession of producers were only three-fourths of those so held a year ago. However, these stocks were fairly well distributed and no early serious shortages were

(Please turn to page 116)

Byproducts Obtained from Coke-Oven Operations in the United States, 1939[1]

(Exclusive of screenings or breeze)

(Data from Bureau of Mines)

Product	Unit	Production	Sales: Quantity	Sales: Value: Total	Sales: Value: Average
Tar	Gal.	554,406,216	344,534,382	$16,585,734	$0.048
Ammonia:					
Sulphate	Lb.	1,160,548,288	1,153,901,833	13,153,642	.011
Ammonia liquor (NH_3 content)	Lb.	48,264,021	48,034,809	1,480,879	.031
		....	....	14,634,521	......
Sulphate equivalent of all forms	Lb.	1,353,604,372	1,346,041,069	....	......
Gas:					
Used under boilers, etc	M cu. ft.	[2]675,143,201	28,714,866	1,967,142	.069
Used in steel or affiliated plants	M cu. ft.		237,890,694	24,301,060	.102
Distributed through city mains	M cu. ft.		144,876,573	42,891,370	.296
Sold for industrial use	M cu. ft.		22,229,157	2,716,883	.122
		....	433,711,290	71,876,455	.166
Light oil and derivatives:					
Crude light oil	Gal.	[3]170,963,199	9,383,907	727,765	.078
Benzol, crude and refined	Gal.	25,305,714	24,621,650	3,248,548	.132
Motor benzol	Gal.	79,607,150	75,082,362	6,934,550	.092
Toluol, crude and refined	Gal.	19,767,200	20,484,568	3,974,367	.194
Solvent naphtha	Gal.	4,788,836	4,660,311	794,323	.170
Xylol	Gal.	4,089,090	4,393,400	1,018,589	.232
Other light-oil products	Gal.	6,247,201	4,193,125	336,072	.080
		[4]139,805,191	142,819,323	17,034,214	.119
Naphthalene, crude and refined	Lb.	48,460,171	46,551,432	727,947	.016
Tar derivatives:					
Creosote oil, distillate as such	Gal.	18,479,962	13,573,393	1,470,608	.108
Creosote oil in coal-tar solution	Gal.	975,887	....	....	......
Pitch of tar	Net tons	215,414	2,109	13,905	6.593
Other tar derivatives	....	....	....	1,734,810	......
Phenol	Gal.	99,365	71,080	28,949	.407
Sodium phenolate	Gal.	288,974	286,949	21,936	.076
Other products[5]	....	....	....	685,355	......
Value of all byproducts sold	....	....	....	[6]124,814,434	......

[1] Includes products of tar distillation conducted by coke-oven operators under same corporate name, except, however, phenol and other tar acids produced at Clairton, Pa. [2] Includes gas wasted and gas used for heating retorts. [3] Refined on premises to make the derived products shown: 163,947,167 gallons. [4] Total gallons of derived products. [5] Ammonia thiocyanate, asphalt paint, cyanogen sludge, calcium ferro-cyanide, light carbolic oils, pyridine oil, sodium carbolate, sodium prussiate, spent soda solution, sulphur, and vented vapors. [6] Exclusive of value of breeze which was $7,271,050.

TURPENTINE AND ROSIN

Loss in export business continued as an unfavorable factor in the market for spirits of turpentine and rosin but improvement in domestic buying offset this somewhat and in the latter part of the period, turpentine staged a price recovery which promised to continue over at least the first half of the present year with crop control and the government lending program extended. Values for rosin remained relatively low.

THAT THE program to curtail domestic production of turpentine and rosin has made headway is shown by the recently issued semi-annual report of the Department of Agriculture which covers the six-month period from April to September inclusive. For that time, production of turpentine is reported at 350,192 50-gal. bbl. compared with 354,702 bbl. for comparable months of the preceding year. During the same periods the output of rosin dropped from 1,348,183 500-lb. bbl. to 1,296,119 bbl.

There were several developments within the industry last year that had a bearing on production and marketing. First was the extension of the conservation program whereby producers might earn government payments by joining the program and observing its provisions. Payments were based on a scale ranging from 1¼¢ to 5¢ a face, the maximum applying to all faces on small trees required to be taken out of operation. Producers were not to work trees under 9 inches in diameter and to work only one face during the season on trees of less than 14 inches in diameter. Efforts were made to have the wood distillation branch of the naval stores industry join with the gum interests in this conservation plan but after deliberations it was decided that this was not advisable for the present.

Still another change which was decided upon last year but which was not to become effective until Jan. 2, 1941, was the establishing of Savannah as the official market through which the greater part of turpentine and rosin was to be marketed. Five other official marketing points are authorized where prices will fluctuate at fixed differentials as determined by that officially established at Savannah.

J. E. Lockwood, Naval Stores consultant, Savannah, has written the following resume of conditions in the industry:

Current conditions in the American Naval Stores industry are clearly shown by the Fifth Semi-Annual Naval Stores Report, as of September 30, 1940, issued by the U. S. Department of Agriculture. It also supplies the essential statistics of turpentine and rosin production, distribution and carryover stocks, for the first half of the 1940-41 naval stores season ending March 31, and the corresponding half of the 1939-40 season. It is in the standard form first issued in 1935, with the added segregated gum and wood statistics, first issued in 1939. From this and the previous semi-annual and annual reports in this standard form, the changes in conditions and trends of the industry can be seen and studied.

Supply and demand conditions of turpentine and rosin for the half-year ended Sept. 30, were about the same as during the corresponding period of 1939, with the exception of further material decrease in exports. The current supply from production and imports, as compared with the total demand for consumption and exports, was such that while the turpentine demand exceeded the current supply and decreased the carryover by nearly 50,000 barrels, yet the rosin supply exceeded the demand sufficiently to further increase the excessive carryover by more than 100,000 round barrels.

As carryover stocks on hand at the close of each season are the key to practically the whole naval stores situation, including Savannah market prices and trends, the following table supplies the carryover of rosin and turpentine for the last five seasons, with the corresponding Savannah prices then effective. I also state in the foot notes following, what carryover of each product I consider "normal" and what is "surplus."

Commenting on the conditions and problems of the industry he stated that turpentine conditions have greatly improved, since the program of modern packaging and national advertising was inaugurated in 1939. The surplus stocks which approximated 200,000 bbl., have been largely reduced and will continue to be gradually absorbed, if advertising and prices satisfactory to consumers are continued. It is now up to the industry to find at what price level the demand will continue sufficient to absorb the remaining surplus and current supply, and then maintain such price levels, to assure such desirable results.

Rosin conditions are, however, a much more difficult and serious problem. Since 1936 the supply has exceeded the demand to such continued extent, that the carryover has steadily increased from approximately 600,000 round bbl. to 1,800,000 bbl.; This indicates a surplus of fully 1,200,000 bbl., or double the surplus of 1921, which was our former largest. That surplus required five years, to absorb and bring back "normal" carryover and prices. Now, unless a new and large consumption, or export market, is developed, it may take twice as long, or possibly more, to absorb our present surplus. This is the most serious problem the industry has ever faced. It is dependent largely upon the program and action of the Commodity Credit Corp., which is holding the entire surplus, under its loans to the industry.

The recent changes in methods of marketing turpentine and rosin on the Savannah Naval Stores Exchange, have proved workable. They are not as popular with the trade members as the former methods. How outside dealers and consumers consider same, is not known as yet. Turpentine is now sold on the "bulk" basis, of 7.2 lb. net per gallon. Barrels when required are included at 6 cents per gal. Rosin, is sold by individual grades, each on the "100 lb. net weight" basis. With conversion tables available, the equivalent price on the old 280 gross weight basis is readily determined.

Carryover (Stocks)

	Turpentine		Rosin	
March 31	Total stocks Bbl. 50 gal.	Sav. Price per gal.	Total stocks Bbl. 500 lb.	Sav. Price H Grade
1940	220,267	$.31	1,569,396	$5.50
1939	314,323	.29	1,621,970	5.70
1938	218,774	.23¼	999,147	4.80
1937	223,364	.36½	663,251	7.85
1936	230,136	.37¾	765,807	4.42½

(a) Sav. price of turpentine includes barrel at 6c

(b) Sav. price of H grade rosin, is considered indicative of all grades.

(c) "Normal" carryovers are:

For Turpentine 125,000 bbl., including London, or 115,000 for U. S. total only.

For Rosin, 550,000 bbl. for U. S. total; And as "Surplus" stocks, all above the "normal" carryover.

Census Data for 1939 and 1937

CHEMICALS NOT ELSEWHERE CLASSIFIED

	1939	1937
Chemicals, miscellaneous		
Total value	$838,217,438	$828,617,444
Acetates, total value	$23,513,827	[2] $19,860,545
Butyl, gallons	9,725,821	9,316,128
Value	$4,497,379	$5,084,985
Chromium, pounds (basis 8½ to 12% Cr_2O_3)	359,807	811,587
Value	$15,754	$37,459
Ethyl, gallons	6,843,317	6,946,081
Value	$2,387,758	$2,919,201
Lead, pounds	1,742,640	1,957,811
Value	$170,357	$206,888
Sodium, pounds	6,965,952	6,169,383
Value	$935,659	$244,003
Other acetates, value	[3] $15,506,920	$11,368,009
Acids, total value	$82,095,014	$84,831,771
Boric (boracic), tons	17,348	20,262
Value	$1,491,651	$1,545,304
Hydrochloric, tons (basis 100%)	78,848	71,166
Value	$3,948,831	$3,987,974
From salt, tons	52,902	53,027
Value	$2,925,444	$3,048,182
From chlorine, by-product and other, tons	25,946	18,139
Value	$1,023,387	$939,792
Hydrofluoric (basis 100%), pounds	4,345,609	4,395,696
Value	$664,600	$701,314
Mixed (sulphuric-nitric), tons	56,517	54,432
Value	$2,696,993	$2,484,864
Nitric, total production (basis 100%), tons	167,740	175,860
Consumed where made, tons	133,169	140,450
For sale, tons	34,571	35,410
Value	$3,184,912	$3,052,576
Oleic, pounds	42,647,332	38,086,776
Value	$3,004,421	$3,604,790
Oxalic, pounds	8,265,490	10,197,652
Value	$868,351	$1,086,878
Phosphoric (basis 50%, H_3PO_4), tons	76,912	39,125
Value	$3,035,333	$1,785,785
Pyrogallic, pounds	54,023	118,669
Value	$64,322	$138,326
Stearic, pounds	33,195,528	31,888,647
Value	$3,550,189	$3,656,422
Sulphuric		
Total production (basis 50° Baume), tons	7,649,814	7,946,695
Consumed where made, tons	2,496,969	2,228,103
For sale, tons	5,152,845	5,718,592
Value	$37,880,707	$42,197,855
Production by process		
Contact		
Total production, tons	4,238,807	3,802,951
Consumed where made, tons	1,332,974	800,433
For sale, tons	2,905,833	3,002,518
Value	$22,775,858	$23,650,589
Chamber		
Total production, tons	3,411,007	4,143,744
Consumed where made, tons	1,163,995	1,427,670
For sale, tons	2,247,012	2,716,074
Value	$15,104,849	$18,547,266
Tannic (basis 100%), pounds	798,069	1,015,914
Value	$333,790	$381,847
Tartaric, pounds	9,814,781	10,642,838
Value	$2,600,682	$2,484,625
Other acids, value	[1] $18,770,232	$17,723,211
Alcohols		
Methyl, synthetic, gallons	34,146,669	31,606,320
Value	$9,319,752	$8,619,238
Butyl, pounds	66,903,538	79,933,577
Value	$4,707,910	$5,866,588
Ethyl and other alcohols, value [22]	$26,493,208	$35,819,524
Ammonia, anhydrous[4], pounds	227,219,049	216,141,910
Value	$8,470,900	$7,787,636
Ammonia, aqua and liquor [5], pounds	31,305,077	26,000,866
Value	$1,438,234	$1,382,768
Bicarbonates and carbonates, total value [32]	$8,839,870	$9,319,933
Sodium bicarbonate, refined, tons (basis 100%)	148,610	142,161
Value	$3,839,018	$3,606,271
Bismuth, subcarbonate, pounds	241,817	247,609
Value	$352,638	$313,426
Copper carbonate (52% Cu), pounds	605,101	814,163
Value	$96,229	$121,776
Calcium carbonate (precipitated chalk), tons	70,504	71,235
Value	$1,645,707	$1,667,280
Sal soda, tons	28,668	33,064
Value	$717,107	$768,659

Bicarbonates, cont.	1939	1937
Zinc carbonate, pounds	288,873	
Value	$31,064	$2,842,521
Other bicarbonates and carbonates, value	[24] $2,158,107	
Soda ash		
Total production, tons (2,000 lbs)	2,961,632	3,037,421
Consumed where made	815,471	713,662
For sale, tons	2,146,161	2,323,759
Value	$32,871,016	$33,768,770
For sale, by process		
Ammonia soda, tons	2,013,264	2,205,006
Value	$31,115,153	$32,306,416
Natural and electrolytic soda, tons	132,897	118,753
Value	$1,755,863	$1,462,354
Bismuth subgallate, pounds	43,347	40,861
Value	$62,285	$55,270
Bromides, total value	$9,521,712	$7,057,218
Sodium, pounds	1,343,992	
Value	$281,654	
Other bromides, value	$9,240,058	
Bromine, pounds	2,228,852	
Value	$506,705	[6]
Calcium carbide, tons	167,592	192,670
Value	$8,494,613	$9,842,378
Carbon, activated, tons	16,168	10,655
Value	$1,881,019	$1,443,936
Carbon bisulphide, pounds	161,523,747	155,237,735
Value	$5,185,708	$4,753,748
Carbon tetrachloride, pounds	84,860,987	78,708,690
Value	$3,322,811	$3,067,611
Chlorides, total value	$18,831,107	[7] $19,651,720
Aluminum (anhydrous, crystal and liquid), tons (basis 100%)	5,024	4,034
Value	$788,134	$623,639
Ammonium (sal ammoniac) pounds	45,522,754	39,599,247
Value	$2,051,348	$1,821,494
Gold, ounces	1,523	2,903
Value	$29,177	$57,995
Calcium [8]		
Solid, tons (basis 73 to 75%)	5,494	4,882
Value	$107,725	$85,556
Flake, tons (basis 77 to 80%)	215,149	223,641
Value	$4,074,880	$3,753,744
Liquid, tons (basis 75%)	18,711	28,927
Value	$186,985	$209,241
Methyl, pounds	3,255,335	3,389,125
Value	$994,758	$1,043,195
Tin (stannous), pounds	588,181	460,841
Value	$230,558	$180,499
Mercury (mercuric and mercurous), pounds	643,253	520,216
Value	$859,249	$603,574
Sulphur, pounds	3,754,885	66,597,534
Value	$96,517	$993,691
Other chlorides, value	[9] $9,411,776	$10,279,092
Chlorine, total production, tons [44]	485,554	446,261
Consumed where made, tons	172,598	160,301
For sale, tons	312,596	285,960
Value	$10,370,507	$10,416,672
Chlorine bleaching compounds,[10] total value	$11,981,532	
Bleaching powder, tons [11]	16,662	
Value	$853,354	
Sodium hypochlorite, and other liquid sodium bleaches, total value	$9,408,160	
Quantity reported, tons [12]	56,479	
Value	$6,762,943	
Quantity not reported		
Value	$2,645,217	
Other lime bleaches, value [13]	$1,720,018	
Chromates and bichromates, total value [14]	$6,818,672	$6,341,154
Sodium, tons	54,385	48,697
Value	$6,399,069	$5,925,611
Potassium, pounds	4,690,734	4,717,202
Value	$404,024	$386,369
Ammonium, pounds	47,956	63,876
Value	$15,579	$28,434
Other chromates and bichromates, value	[15]	$740
Citrates, total value	$1,026,266	$947,701
Iron ammonium, pounds	280,263	340,863
Value	$94,836	$108,413
Potassium, pounds	159,420	200,573
Value	$53,681	$72,217
Other citrates, value	[25] $877,749	$767,071
Coal-tar products, total value	$171,927,271	$157,743,971
Crudes [41]	$25,472,726	$29,470,712
Intermediates	$41,120,860	$37,139,888
Finished [29]	$105,333,685	$91,133,371

	1939	1937
Cyanides, total value	$4,103,133	$4,883,777
Copper, pounds	889,721	738,683
Value	$297,712	$264,244
Silver, ounces	248,532	
Value	$96,393	$4,619,533
Other cyanides, value	[30] $3,709,028	
Ester gum, pounds	28,221,892	25,589,993
Value	$1,817,493	$2,212,945
Ferro-alloys, electric furnace, tons (2,240 lbs.)	258,199	352,318
Value	$35,202,818	$45,295,278
Fluorides, value [16]	$1,776,290	$5,133,706
Hydroxides, total value	$37,626,476	$34,748,487
Potassium (caustic)		
Made for sale, tons (basis 100% KOH)	13,856	10,839
Value	$1,831,272	$1,437,509
Sodium (caustic)		
Total production, tons (basis 76% Na_2O)	1,025,011	968,726
Consumed where made, tons	74,854	71,315
Made for sale, tons	950,157	897,411
Value	$34,541,479	$32,027,796
For sale by process		
Electrolytic, tons	426,250	415,477
Value	$15,094,950	$14,137,170
Lime soda, tons	523,907	481,934
Value	$19,446,529	$17,890,626
Other hydroxides, value	$1,253,725	$1,283,182
Iodides, total value	$1,242,005	$793,609
Potassium, pounds	914,926	612,696
Value	$1,074,653	$599,027
Sodium, pounds	39,625	42,062
Value	$76,463	$81,413
Thymol, pounds	6,670	8,402
Value	$20,009	$27,919
Other iodides, value	$70,880	$85,250
Iodine, resublimed, pounds	404,344	369,278
Value	$457,199	$399,088
Lactates, value	$222,097	$236,884
Light alumina hydrate, pounds	3,207,701	
Value	$357,307	[17]
Linoleates, value	$152,834	$159,143
Mercury, ammoniated, pounds	54,277	57,230
Value	$98,586	$100,789
Mercury, redistilled, pounds	270,713	162,196
Value	$376,467	$221,801
Modified sodas, tons	32,101	26,497
Value	$1,265,288	$1,050,953
Nitrates, except sodium, Total value	$8,928,280	$8,835,389
Bismuth, sub, pounds	365,522	262,867
Value	$487,502	$309,678
Ammonium, pounds	51,935,228	45,560,194
Value	$1,341,317	$1,130,764
Iron, pounds	1,020,800	
Value	$33,583	$7,394,947
Other nitrates, except sodium, value	[28] $7,065,878	
Non-ferrous alloys, electric furnace, value	$612,200	[6]
Oxalates, total value	$261,378	$254,439
Iron, pounds	13,683	
Value	$10,172	$254,439
Other oxalates, value	[31] $251,206	
Oxides, total value	$10,196,588	$8,373,522
Mercury, pounds	427,207	162,224
Value	$669,041	$218,075
Tin, pounds	6,621,608	3,323,715
Value	$2,913,040	$1,707,451
Chromium, pounds	2,870,330	2,875,060
Value	$665,025	$603,000
Other oxides, value	[27] $5,949,482	$5,844,996
Peroxides, total value	$4,387,041	$4,789,902
Hydrogen, pounds (basis 100 volumes)	21,487,968	22,924,978
Value	$3,450,217	$3,781,229
Other peroxides, value	[34] $936,824	$1,008,673
Phosphates, total value	$20,093,102	$16,118,041
Calcium		
Monobasic, tons	37,038	38,708
Value	$4,370,972	$4,960,017
Dibasic and tribasic, tons	7,313	4,354
Value	$663,640	$395,007
Sodium		
Tribasic, tons	114,687	117,402
Value	$4,819,809	$4,235,155
Dibasic, tons [18]	13,627	22,330
Value	$1,207,322	$814,420
Monobasic, tons	3,197	2,553
Value	$436,736	$374,178
Pyro, tons	42,210	10,288
Value	$4,199,996	$1,360,882
Other phosphates, value	[19] $4,394,627	$3,978,382

CHEMICALS, N. E. C., Cont.	1939	1937
Salicylates, total value	$579,199	$565,690
Sodium, pounds	497,423	
Value	$195,180	
Other salicylates, value	[33] $384,019	
Sodium antimonate, pounds	4,748,697	4,347,866
Value	$612,975	$554,047
Sodium benzoate, pounds	1,607,318	[6]
Value	$500,877	[6]
Sodium hyposulphite (thiosulphate), tons	25,714	33,093
Value	$1,142,087	$1,411,764
Sodium silicate		
Liquid, tons (basis 40°)	655,379	600,979
Value	$7,298,463	$6,786,715
Solid, tons	46,012	40,473
Value	$1,799,082	$1,568,134
Sodium silicofluoride, tons	6,443	6,601
Value	$482,292	$582,623
Stearates, total value	$1,407,258	$1,773,468
Aluminum, tons	1,806	2,258
Value	$601,701	$856,771
Calcium, pounds	768,504	980,101
Value	$154,406	$191,839
Zinc, pounds	2,035,960	2,073,110
Value	$431,226	$421,463
Magnesium, pounds	104,689	111,734
Value	$23,199	$24,623
Other stearates, value	$196,726	$278,772
Sulphates, total value	$22,888,963	[37] $25,079,256
Aluminum (concentrated alum), tons	416,108	393,411
Value	$8,455,376	$8,958,601
Aluminum-ammonium (ammonia alum), tons	5,065	5,390
Value	$268,344	$278,037
Potash and chrome alum, tons	2,683	3,227
Value	$168,802	$203,960
Magnesium (Epsom salt), tons	47,689	41,369
Value	$1,409,398	$1,216,748
Manganese, pounds (100% basis)	11,575,626	12,518,876
Value	$308,604	$341,781
Zinc, pounds	28,821,165	37,530,157
Value	$704,235	$1,143,284
Iron, tons	35,214	43,916
Value	$442,573	$447,409
Sodium, total value	$4,128,507	$3,692,162
Anhydrous (refined) [38], tons	42,498	21,797
Value	$689,599	$312,285
Glauber's salt [39], tons	34,493	31,934
Value	$539,770	$490,660
Niter cake, tons	34,101	22,983
Value	$607,284	$521,601
Salt cake (crude) [40], tons	224,749	241,347
Value	$2,291,944	$2,367,616
Nickel, pounds	7,046,561	
Value	$774,868	
Other sulphates, value [41]	[42] $6,228,166	$8,817,274
Sulphides, total value	$2,297,464	$2,343,776
Sodium, tons (basis 60 to 62%)	31,481	27,266
Value	$1,633,895	$1,529,592
Cadmium, pounds	141,611	
Value	$143,517	$814,184
Other sulphides, value	$520,052	
Sulphites, total value	$5,242,351	$3,923,509
Sodium, normal [20], tons	11,213	12,491
Value	$693,773	$781,877
Sodium, formaldehyde and zinc-hydro, pounds	23,446,139	16,032,500
Value	$3,576,658	$2,503,683
Other sulphites, value	$971,920	$638,039
Sulphur dioxide, pounds [32]	26,861,151	28,717,125
Value	$1,291,393	$1,477,146
Tartrates, total value	$1,413,337	$1,302,411
Potassium, bi-(cream of tartar), pounds	3,815,317	5,080,455
Value	$795,035	$883,646
Other tartrates, value	$618,302	$418,765
Vitreous enamels, pounds	89,720,751	110,879,218
Value	$7,211,025	$6,826,215
Other inorganic chemicals [21], value	[22] $71,358,027	135,450,083
Other organic chemicals [30], value	$118,113,039	$75,063,745

[1] Includes in order of value, statistics for acetic anhydride, citric acid, molybdic acid (oxide), synthetic acetic acid, etc.

[2] Revised to exclude calcium acetate which is now included in "Hardwood Distillation and Charcoal."

[3] Includes in order of value, cellulose acetate, amyl acetate, vinyl acetate, isopropyl acetate, cobalt acetate, aluminum acetate, etc.

[4] Includes production from ammonia liquor.

[5] Figures for 1937 but not for 1939 include data for ammonia produced in the manufacture of gas.

[6] Withheld to avoid disclosing data reported by individual establishments.

[7] Revised to include methyl chloride.

[8] Does not include calcium chloride from establishments engaged primarily in the production of salt. Such production in 1939 amounted to 2,840 tons, in 1937, 7,303 tons.

[9] Includes in order of value, potassium chloride, ethyl chloride, zinc chloride, ethylene dichloride, iron chloride, barium chloride, etc.

[10] Included in value of "Other Inorganic Chemicals" in 1937.

[11] Basis 35 to 37 percent available chlorine.

[12] Basis 15 percent available chlorine.

[13] Includes value for liquid lime bleaches and calcium hypochlorite (true).

[14] Does not include production of chromates for use as dry colors.

[15] None reported.

[16] Includes value of carbon flourides for 1937 but not for 1939.

[17] No data available.

[18] For 1939, basis 100 percent Na_2HPO_4. For 1937, as reported, regardless of strength.

[19] Includes in order of value, ammonium phosphate, sodium metaphosphate, etc.

[20] Anhydrous and crystal.

[21] Includes value for aluminum metal for 1937 but not for 1939.

[22] Includes in order of value, data for sodium nitrate, sodium borate, yellow phosphorus, sodium metal, magnesium metal, calcium molybdate, etc.

[23] Does not include data for soda ash.

[24] Includes in order of value, statistics for potassium carbonate, barium carbonate, ammonium bicarbonate, etc.

[25] Includes in order of value, statistics for sodium citrate, lithium citrate, tri-ethyl citrate, etc.

[26] Includes in order of value, statistics for sodium cyanide, sodium ferrocyanide, potassium ferrocyanide, etc.

[27] Includes in order of value, statistics for antimony oxide, aluminum oxide, magnesium oxide, etc., but not abrasive or refractory aluminum oxide.

[28] The production of ethyl alcohol, as reported to the Bureau of Internal Revenue, Treasury Department, was 217,485,249 proof gallons in 1939 and 215,438,282 proof gallons in 1937.

[29] Does not include data for color lakes, see "Colors and Pigments."

[30] Includes in order of value, statistics for tetraethyl lead, nitrocellulose (not plastic), ethylene glycol, formaldehyde, acetone, etc.

[31] Includes in order of value, statistics for iron-ammonium oxalates, ethyl oxalate, sodium oxalate, etc.

[32] Included in the "Compressed and Liquified Gases" industry in 1937.

[33] Includes in order of value, statistics for methyl salicylate, bismuth subsalicylate, strontium salicylate, etc.

[34] Includes in order of value, statistics for sodium peroxide, barium peroxide, etc.

[35] Includes in order of value, statistics for Rochelle salts, tartar emetic, etc.

[36] Includes in order of value, statistics for silver nitrate, lead nitrate, potassium nitrate, etc.

[37] Revised to exclude barium sulphate which is now included in the "Colors and Pigments" and sodium hyposulphite now reported as a separate item.

[38] Includes statistics for anhydrous sodium sulphate made from brine.

[39] Includes statistics for Glauber's salt refined from natural product.

[40] Includes statistics for natural salt cake made from brines.

[41] Data for satin white included for 1937, excluded for 1939.

[42] Includes in order of value, statistics for copper sulphate, ammonium sulphate, soda-alum, etc.

[43] Not including by-product crudes made in coke plants and gas works.

[44] Not including chlorine produced in establishments classified in the pulp and paper industries.

BLACKS

	1939	1937
Aggregate, pounds	562,735,186	551,487,116
Value	$14,927,209	$19,578,693
Bone black, pounds	29,726,998	35,571,397
Value	$1,388,760	$1,717,160
Carbon black, pounds	526,166,000	510,606,343
Value	$12,857,000	$17,389,000
Lampblack, pounds	7,842,188	5,309,376
Value	$681,449	$472,533
Made as secondary products in other industries, value	$543,600	$1,023,969

CEMENT

	1939	1937
Total, barrels	124,689,264	118,075,351
Value	$184,254,932	$171,414,093
Portland cement, barrels	122,259,154	116,174,708
Natural, puzzolan, and masonry, barrels	2,439,110	1,900,643

CLEANING AND POLISHING PREPARATIONS

	1939	1937
Aggregate value	$89,236,580	[1] $80,831,454
Cleaning preparations		
Containing no soap, value	$25,810,813	$23,985,509
Containing soap, value [2]	$13,784,830	[1] $10,583,407
Polishing preparations, value	$47,816,215	$44,626,532
Paint and varnish removers, value	$1,824,722	$1,635,916

[1] Revised. [2] Not including cleansers containing soap made by establishments classified in the "Soap and Glycerin" industry.

COMPRESSED AND LIQUEFIED GASES

	1939	1937
Aggregate value [1]	$58,217,965	$59,871,528
Carbon dioxide (not including "dry ice")[2], pounds	102,208,118	100,715,662
Value	$4,657,037	$4,939,508
Solidified carbon dioxide ("dry ice"), pounds	356,893,516	313,217,310
Value	$5,532,315	$4,618,937
Hydrogen, M cubic feet	1,124,168	1,103,177
Value	$1,549,103	$1,848,529
Hydrocarbon gases		
Acetylene, M cubic feet	1,274,104	1,511,445
Value	$16,466,782	$19,166,420
Other hydrocarbon gases, value	$944,044	$813,775
Nitrous oxide, M gallons	95,577	97,768
value	$858,514	$1,114,113
Oxygen, M cubic feet, total	4,561,968	4,441,391
Liquefaction process	4,452,209	4,318,410
Electrolytic process	109,759	122,981
Value	$24,015,233	$26,072,822
Other gases, value [3]	$4,194,937	$1,297,424

[1] Data for ammonia (anhydrous), chlorine, methyl chloride, and sulphur dioxide are now included in the "Chemicals not Elsewhere Classified" industry and data for liquefied petroleum gases are included in the "Petroleum Refining" industry. [2] Includes carbon dioxide piped to plants making "dry ice." Quantities thus piped in 1939 and 1937 (estimated) were 15,000,000 pounds and 17,000,000 pounds, respectively. [3] Includes value of carbon fluorides for 1939 but not for 1937.

DRUGS AND MEDICINES

	1939	1937
Aggregate value	$361,742,760	$344,179,452
Alkaloids and derivatives, made for sale, total ounces	37,246,279	18,955,603
Total value	$8,900,149	$8,620,289
Biological products, total value	$21,767,222	$16,769,864
Other products sold to or prescribed by physicians, value	$148,263,116	$116,945,687
Drugs and medicines in specially prepared packages, advertized for sale to the general public, value	$166,577,263	$184,309,381

EXPLOSIVES, MATCHES, AMMUNITION

	1939	1937
Explosives, aggregate value	$61,321,713	$60,095,957
Dynamite, pounds	257,326,065	256,647,677
Value	$26,949,869	$26,949,869
Permissible explosives [1] pounds	76,438,168	71,289,248
Value	$7,734,454	$7,466,338
Nitroglycerin, made for sale, pounds	347,328	
Value	$69,340	
Made and consumed in shooting wells, pounds	1,703,791	[3] 3,433,594
Amount received for shooting wells on contract, value [2]	$2,064,143	[3] $1,636,919
Blasting powder, pounds	29,440,225	32,192,875
Value	$1,768,732	$2,009,925
Pellet powder, pounds	26,670,405	33,423,657
Value	$1,604,806	$2,137,152
Fuse powder, pounds		2,438,775
Value		$438,109
Gunpowder (black and smokeless) and other explosives not specified above	[3] $12,062,008	$8,126,673
Fireworks, aggregate value	$4,552,906	$5,377,357
Ammunition, total value	$28,268,444	$29,738,639
Matches, total value	$25,577,201	$30,902,138

[1] Those approved by the Bureau of Mines, Department of the Interior, as suitable for use in mines where dust and gas explosions are likely to occur. [2] Amount received for shooting wells is treated as value of nitroglycerin used for this purpose. [3] Combined to avoid disclosing data reported by individual establishments.

FATS AND OILS

	1939	1937
Cooking and other edible fats and oils		
Value	$186,252,453	$230,495,067

FATS AND OILS, Cont.	1939	1937
Cottonseed oil, cake, meal and linters		
Crude cottonseed products, total value	$153,185,000	$229,183,000
Oil, pounds	1,409,413,537	1,363,978,069
Value	$86,601,000	$123,189,000
Cake and meal, tons	2,023,341	2,031,488
Value	$47,194,000	$65,783,000
Hulls, tons	1,161,079	1,144,138
Value	$7,123,000	$10,472,000
Linters, bales	1,113,312	1,126,873
Value	$12,267,000	$29,739,000
Cottonseed crushed, tons	4,470,516	4,498,321
Essential oils		
Value	$9,813,799	$5,138,886
Fish and other marine oils, cake and meal		
Value	$13,622,312	$11,503,312
Linseed oil, cake and meal		
Linseed oil,[1] pounds	534,498,322	638,171,128
Value	$45,623,756	$59,848,229
Cake and meal,[1] tons	519,131	587,832
Value	$16,819,968	$21,421,083
Soybean oil, cake and meal		
Value	$43,946,647	$24,312,433
Vegetable and animal oils N. E. C.		
Value	$30,456,835	$36,200,028

[1] Figures represent production in the Linseed Oil industry only and therefore do not cover the output of linseed oil, cake, and meal made as secondary products by establishments classified in other industries, which in 1939 amounted to 28,253,034 pounds of oil, valued at $2,235,848 and 27,058 tons of cake and meal, valued at $867,613. The combined production of linseed oil was: 1939, 564,507,734 pounds; 1937, 665,098,850 pounds.

FERTILIZERS

	1939	1937
Fertilizers, aggregate value	$161 887 134	$173 647 111
Complete fertilizers, tons	5,088,468	5,680,619
Value	$117,666,262	$128,750,181
Potash superphosphate, tons	233,355	225,589
Value	$4,824,707	$4,458,662
Superphosphates, not ammoniated,[1] total production, tons	[2] 4,152,269	5,275,710
Made for sale, tons	2,756,967	3,112,563
Value	$23,937,497	$27,846,266
Made and consumed, tons	1,395,302	2,163,147
Bone meal, tons	62,004	84,913
Value	$1,760,942	$1,919,503
Ammoniated superphosphates, tons	32,878	45,352
Value	$572,756	$700,842
Other ammoniated fertilizers, tons	6,834	7,734
Value	$138,678	$144,112
Other fertilizers,[3] tons	360,146	218,844
Value	$6,660,877	$4,998,520
Tankage, tons	225,575	179,715
Value	$6,325,415	$4,829,025

[1] Basis 16 percent available phosphoric acid. [2] In addition, 68,926 tons of superphosphate, basis 47 percent P_2O_5, was produced by the Tennessee Valley Authority during the fiscal year ended June, 1939. [3] Includes legume inoculants.

GLASS AND GLASSWARE

	1939	1937
Glass and glass products, aggregate value	$320,405,252	$354,038,944
Flat glass, value	$71,385,597	$100,938,681
Glass containers, value	$156,364,837	$162,206,674
Glassware n. e. c., value	$92,654,818	$90,893,589

GLUE AND GELATINE

	1939	1937
Aggregate value[1]	$34,443,554	$41,297,643
Glue, total value	$23,885,651	$30,152,196
Animal, pounds	101,092,117	121,126,526
Value	$11,106,202	$17,386,088
Vegetable, pounds	178,474,477	229,995,918
Value	$9,106,285	$8,621,874
Casein, pounds	10,239,221	7,982,056
Value	$1,130,229	$1,072,395
Flexible and fish,[2] pounds	14,588,017	15,873,966
Value	$2,321,842	$2,411,581
Gelatin, pounds	29,144,225	29,493,928
Value	$10,557,903	$11,145,447
Edible, pounds	22,373,480	22,020,617
Value	$7,299,741	$7,789,419
Inedible and photographic,[2] pounds	6,770,745	7,473,311
Value	$3,258,162	$3,356,028

[1] Figures include an indeterminate amount of duplication due to the use of animal and vegetable glue in the production of flexible glue. [2] Figures combined to avoid disclosing approximations of the output of individual manufacturers.

GREASE AND TALLOW[1]

	1939	1937
Aggregate value	$59,930,992	$64,128,602
Grease (including soap stock), pounds	338,663,220	339,481,737
Value	$16,267,531	$21,906,757
Tallow, total pounds	861,115,490	568,034,827
Value	$43,663,461	$42,221,845
Edible, pounds	79,153,261	62,352,668
Value	$4,214,289	$4,886,448
Inedible, pounds	781,962,229	505,682,159
Value	$39,449,172	$37,335,397

[1] Not including lubricating greases.

GUM TURPENTINE AND ROSIN

	1939	1937
Turpentine, total barrels (50 gals.)	[1] 407,135	[2] 518,454
Quantity and value reported, Barrels[1]	400,535	515,092
Value (at the still)[1]	$4,083,877	$7,425,520
Quantity only reported, barrels	[1] 6,600	[2] 3,362
Rosin, total barrels (500 lbs. gross)	[1] 1,319,896	[2,3] 1,709,157
Quantity and value reported, Barrels[1]	1,297,509	1,642,594
Value (at the still)[1]	$12,735,672	$21,175,211
Quantity only reported, barrels	[1] 22,387	[2] 66,563

[1] Calendar year. [2] Crop year ended March 31, 1938. [3] Exclusive of 26,271 barrels of reclaimed gum rosin.

HARD SURFACE FLOOR COVERINGS

	1939	1937
Linoleum and asphalted-felt-base floor covering industry, all products, total value	$69,874,978	$69,184,041
Linoleum,[1] square yards	36,004,785	35,744,655
Value	$29,432,896	$29,574,374
Asphalted-felt-base floor coverings, total square yards	164,221,495	156,080,523
Value	[2] $37,880,604	[2] $36,461,951
Piece goods, square yards	82,750,211	79,223,081
Value	$18,415,295	$17,146,069
Rugs, square yards	81,471,284	76,847,442
Value	[2] $19,465,309	[2] $19,315,882

[1] All piece goods except a small quantity of inlaid-linoleum rugs, the data for which are included in the figures for "inlaid" to avoid disclosing the production reported by an individual establishment. [2] Includes a small value reported for other hard-surfaced floor coverings to avoid disclosing data reported by individual establishments.

INSECTICIDES AND RELATED CHEMICAL COMPOUNDS

	1939	1937
Disinfectants and insecticides, total value	$45,672,588	$43,394,019
Agricultural insecticides and fungicides, total value	$20,097,939	$19,712,767
Calcium arsenate, pounds	39,281,788	37,001,959
Value	$1,911,896	$1,879,253
Lead arsenate, pounds	59,568,596	63,291,440
Value	$5,421,771	$5,540,885
Lime-sulphur solution, gallons	9,491,068	10,864,924
Value	$924,705	$1,013,239
Paris green, pounds	2,040,307	1,834,340
Value	$460,323	$336,152
Rotenone, pounds	3,244,706	
Value	$566,646	[1]
Sulphur dust, pounds	36,707,922	
Value	$998,647	[2]
Other agricultural insecticides and fungicides, including lime-sulphur, dry, and nicotine sulphate, value	$9,813,951	$10,943,238
Household insecticides and repellants, total value	$18,113,699	$17,366,900
Disinfectants, value	$7,460,950	$6,314,352
Boiler compounds, value	$3,863,180	$4,318,720
Insulating compounds, value	$1,955,417	$1,982,952
Household ammonia, value	$921,986	$869,740
Household dyes, value	$2,713,434	$3,274,961
Metal and oil treating compounds, value	$8,486,634	$5,332,449
Waterproofing compounds, Value	$1,840,892	$1,235,217
Water treating compounds, Value	$4,845,949	[1]
Other compounds, value[3]	$42,141,772	$44,618,074

[1] No data. [2] Withheld. [3] Includes foundry supplies, automotive chemical compounds, buffing compounds, furnace cement, incense, soldering and welding compounds, etc.

LIME

	1939	1937
Lime, tons	[1] 4,518,770	3,659,648
Value	[2] $28,718,970	$26,739,911
Quicklime, tons	2,281,528	2,143,517
Value	$14,995,144	$14,847,633
Hydrated lime, tons	1,251,144	1,119,437
Value	$10,267,459	$9,698,984
Agricultural lime, tons	[1] 986,098	396,694
Value	[1] $3,456,367	$2,193,294

[1] Includes 634,165 tons of ground limestone valued at $1,220,630.

LUBRICATING OILS AND GREASES

	1939	1937
Lubricating oils, total gallons	98,112,141	87,810,534
Total value	$25,508,261	$20,194,377
Made, gallons	28,969,193	
Value	$7,542,558	
Compounded or blended, gallons	61,052,418	87,077,956
Value	$16,715,504	$19,581,391
Reclaimed, gallons	8,090,530	4,732,578
Value	$1,250,199	$612,986
Lubricating greases, pounds	281,016,863	278,419,213
Value	$16,109,598	$16,442,561
Lubricants (kind and quantity not reported)	$1,118,811	$546,698

MISCELLANEOUS

	1939	1937
Dyeing and finishing cotton, rayon, silk, and linen textiles industry, value	$271,167,139	$205,091,074
Fuel briquets, value[1]	$5,171,174	$6,137,660
Gypsum products, value	$46,241,980	$42,616,511
Salt, value	$27,530,172	$27,909,013
Perfumes, cosmetics and other toilet preparations, value	$147,465,585	$132,336,481

[1] Total production of briquets (including those made as secondary products in other industries) was, in 1939, 892,000 tons, valued at $5,802,000, and in 1937, 996,000 tons, valued at $6,394,000.

PAINTS, PIGMENTS AND VARNISHES

	1939	1937
Aggregate value	$526,676,869	$552,784,252
Dry colors and pigments, total value	$110,802,139	$117,477,936
White lead (basic carbonate and sulphate), pounds	119,571,570	144,313,029
Value	$7,115,870	$9,450,759
Lead Oxides, total value	$15,918,767	$18,854,145
Litharge		
Made and consumed, pounds	32,340,072	44,216,684
Made for sale and interplant transfer, pounds	164,454,772	165,628,019
Value	$9,230,853	$12,102,184
Red lead, minium, and other pounds	104,881,475	90,223,322
Value	$6,687,914	$6,751,961
Zinc oxide, pounds	301,895,235	321,889,816
Value	$14,431,992	$15,316,173
Lithopone, total production, pounds	313,568,246	366,018,427
Made and consumed, pounds	30,364,024	40,918,543
Made for sale and interplant transfer, pounds	283,204,222	325,099,884
Value	$11,973,519	$13,760,312
Iron oxides (natural and synthetic), pounds	101,949,630	128,891,324
Value	$3,275,941	$4,067,840
Titanium dioxide, pounds	161,708,130	[1]
Value	$17,422,336	
Other oxides, pounds	203,614,895	328,138,379
Value	$8,942,792	$22,458,369
Other mineral colors,[2] pounds	31,207,511	152,105,207
Value	$1,644,802	$6,688,338
Other fine color pigments, pounds	16,285,783	12,397,763
Value	$4,096,431	$2,689,443
Whiting, total production, pounds	121,411,553	147,313,121
Made and consumed, pounds	21,695,120	23,318,491
Made for sale and for interplant transfer, pounds	110,716,433	123,994,630
Value	$764,941	$866,736
Paints, total value	$190,459,858	$200,846,090
Water paints and calcimines, dry or paste, pounds	138,308,902	150,876,090
Value	$6,938,225	$7,621,816
Paints in paste form, pounds	253,895,535	269,826,849
Value	$25,113,592	$28,540,716
Varnishes, lacquers, enamels, and japans, total value	$216,579,605	$226,002,701
Varnishes, value	$63,608,132	$64,730,411
Varnish stains, gallons	2,229,952	2,160,801
Value	$3,577,317	$3,567,419
Nitrocellulose (pyroxylin) products, total value	$64,307,131	$72,272,824
Enamels, total value	$75,943,835	$75,270,124

PAINTS, Cont.	1939	1937
Drying japans and driers, gallons	2,700,148	3,522,010
Value	$2,211,302	$2,946,870
Baking japans, gallons	1,939,737	3,266,880
Value	$1,541,047	$2,507,547
Other products of the varnish group, value	$5,390,841	$4,707,506
Fillers, total value	$1,831,559	$2,110,756
Putty, pounds	103,232,417	90,544,189
Value	$3,811,368	$3,683,418
Bleached shellac, pounds	16,282,716	14,639,005
Value	$3,165,340	$2,664,351

[1] Data not available. [2] Including zinc sulphide.

PAPER AND PAPERBOARD

	1939	1937
Aggregate value [1]	$847,276,506	$887,920,461
Tons	13,493,476	12,837,003
Newsprint, tons	954,259	975,854
Value	$39,764,572	$37,086,644
Ground-wood printing and specialty papers, tons	540,342	518,532
Value	$33,876,716	$32,617,672
Book paper, tons	1,534,591	1,510,011
Value	$138,846,261	$145,589,030
Cover paper, tons	19,401	24,437
Value	$3,449,354	$4,435,204
Text paper, tons	12,339	10,512
Value	$2,305,586	$1,753,572
Writing paper (fine), tons	594,594	578,147
Value	$83,973,218	$87,271,592
Wrapping paper, tons	2,238,993	2,053,387
Value	$174,404,823	$179,734,517
Tissue paper, tons	665,723	540,152
Value	$64,531,114	$55,914,224

PAPER, Cont.	1939	1937
Absorbent paper, tons	118,717	138,064
Value	$19,100,183	$22,120,473
Building paper, tons	645,924	608,086
Value	$29,972,376	$32,630,126
Other paper, tons	63,625	77,985
Value	$8,473,701	$11,427,872
Boards, tons	6,104,968	5,802,036
Value	$248,578,602	$277,339,535

[1] Includes data for paper and paperboard made and used in the same plants in the manufacture of converted paper products, as follows: 1939, 1,454,308 tons valued at $89,581,504; 1937, 1,135,746 tons valued at $77,300,555.

PETROLEUM REFINING

	1939	1937
Refinery products, aggregate value	$2,453,753,562	$2,537,060,775
Gasoline, gallons	24,393,809,047	22,626,325,189
Value	$1,424,436,179	$1,447,688,118
Naphtha, gallons	392,771,685	319,983,096
Value	$23,111,763	$22,031,591
Kerosene, gallons	2,710,108,704	2,508,045,150
Value	$112,064,645	$123,681,070
Fuel oils, gallons	19,983,006,278	19,243,713,721
Value	$472,209,414	$512,904,099
Partially refined oils, sold for rerunning, gallons	1,331,987,486	1,147,454,232
Value	$38,878,489	$38,726,391
Lubricating oils,[1] gallons	1,606,830,052	1,517,102,553
Value	$237,161,245	$245,666,434
Road oils, gallons	861,772,078	592,556,892
Value	$25,680,795	$19,521,797
Residuum or tar, gallons	52,029,686	20,421,403
Value	$822,242	$853,393
Greases, gallons	61,884,768	61,925,798

PETROLEUM, Cont.	1939	1937
Value	$17,323,676	$17,215,900
Paraffin wax, gallons	90,649,364	90,608,190
Value	$19,484,714	$19,213,203
Acid oil, gallons	55,272,890	57,633,349
Value	$784,433	$1,015,991
Liquefied petroleum gases, gallons	133,297,473	101,075,825
Value	$1,495,670	$3,355,409
Asphalt, other than liquid asphalt, tons	2,344,595	2,971,038
Value	$20,852,435	$31,352,147
Petroleum coke, tons	1,521,740	1,327,238
Value	$4,987,247	$5,048,049
Other refinery products, value	$51,460,615	$48,787,183

[1] Production in the Petroleum Refining industry only.

PLASTIC MATERIALS

	1939	1937
Aggregate value	$79,752,810	$61,877,690
Nitrocellulose (pyroxylin) sheets, rods and tubes		
Total production,[2] pounds	13,357,116	18,122,788
Made and consumed, pounds	2,149,179	3,271,971
Produced for sale, pounds	11,207,637	14,850,817
Value	$8,495,519	$12,526,206
Cellulose acetate		
Sheets, rods, and tubes,[3] Pounds	8,743,139	18,923,663
Value	$6,588,247	$12,199,744
Molding composition, pounds	11,537,032	1
Value	$5,222,946	
Coal-tar resins		
Total pounds	152,121,989	131,568,162
Total value	$29,406,947	$23,583,627

CENSUS OF MANUFACTURERS: 1939

SUMMARY BY GROUPS OF INDUSTRIES: 1939 AND 1937

Group	Census Year	Number of Establishments	Salaried Personnel [1, 2]	Wage Earners (average for the year)[2, 3]	Salaries [1, 4]	Wages [4]	Cost of Materials, etc., and Contract Work [4, 5]	Value of Products [4, 5]
All groups, total	1939	184,244	1,049,468	7,887,242	$2,542,040,011	$9,089,927,984	$32,118,242,488	$56,828,807,223
	1937	166,794	1,217,171	8,569,231	2,716,866,216	10,112,882,711	35,539,332,824	60,712,871,737
1. Food and kindred products	1939	51,454	113,232	824,009	262,187,331	913,981,553	7,021,283,375	10,603,950,671
	1937	48,763	138,869	890,503	283,354,199	981,409,373	7,924,135,084	11,294,889,859
2. Tobacco manufactures	1939	765	4,757	87,525	11,355,748	68,439,717	972,036,787	1,322,189,139
	1937	852	5,693	92,158	12,085,233	70,291,395	947,628,432	1,272,687,918
3. Textile-mill products and other fibre manufactures	1939	6,293	61,997	1,075,702	149,762,645	902,171,863	2,088,094,158	3,897,437,872
	1937	5,959	59,458	1,131,224	142,562,196	967,350,312	2,294,345,428	4,065,525,758
4. Apparel and other finished products made from fabrics and similar materials	1939	20,365	53,472	758,302	132,455,695	660,609,295	1,963,505,060	3,358,255,400
	1937	16,422	61,065	699,545	133,614,800	607,061,633	1,908,594,127	3,167,177,238
5. Lumber and timber basic products	1939	11,520	24,607	360,613	51,908,720	310,381,443	504,233,270	1,122,057,978
	1937	10,420	25,402	387,514	53,399,573	339,786,853	512,474,823	1,146,284,625
6. Furniture and finished lumber products	1939	8,457	32,349	293,820	73,403,617	274,733,251	640,955 985	1,267,724,013
	1937	7,559	34,858	310,449	75,618,502	299,211,859	681,387,389	1,317,650,487
7. Paper and allied products	1939	3,279	31,069	264,715	84,868.716	309,856,579	1,149,666,420	2,019,568,217
	1937	3,084	33,099	266,948	84,416,463	310,136,538	1,213,558,936	2,076,425,001
8. Printing, publishing and allied industries	1939	24,879	142,912	324,615	331,673,493	493,643,339	812,267,409	2,578,494,382
	1937	22,674	204,027	350,956	421,146,530	530,213,843	790,226,793	2,576,818,286
9. Chemicals and allied products	1939	9,203	63,109	287,136	165,144,382	356,184,902	1,854,140,407	3,733,657,723
	1937	8,010	72,541	313,506	169,964,461	377,439,945	1,942,959,240	3,719,400,783
10. Products of petroleum and coal	1939	989	18,547	105,428	48,106,292	173,710,817	2,278,543,591	2,953,973,409
	1937	739	19,060	113,606	45,516,534	186,002,864	2,418,664,859	3,038,202,778
11. Rubber products	1939	595	18,636	120,740	44,436,839	161,409,811	496,174,017	902,328,802
	1937	478	20,147	129,818	45,022,086	171,304,546	514,260,412	883,032,546
12. Leather and leather products	1939	3,508	23,865	327,663	55,195,641	294,289,718	805,901,414	1,389,513,718
	1937	3,249	25,305	328,551	54,150,592	308,026,580	891,229,180	1,475,009,070
13. Stone, clay, and glass products	1939	7,024	32,961	287,522	78,817,363	329,589,927	528,792,323	1,440,151,489
	1937	6,196	33,907	306,212	75,062,129	355,450,664	538,160,089	1,428,411,398
14. Iron and steel and their products, except machinery	1939	8,993	117,116	966,371	297,527,758	1,313,633,202	3,635,910,704	6,591,530,456
	1937	8,382	129,792	1,140,928	322,219,884	1,619,788,388	4,056,338,113	7,445,350,168
15. Nonferrous metals and their products	1939	5,600	34,562	228,753	86,081,442	299,219,667	1,748,179,675	2,572,854,496
	1937	5,173	39,755	255,767	91,703,622	336,348,936	1,934,185,300	2,779,961,323
16. Electrical machinery	1939	2,014	57,528	256,467	139,614,726	335,819,534	727,436,259	1,727,217,631
	1937	1,507	68,287	306,003	151,521,926	407,960,508	797,772,309	1,899,905,431
17. Machinery (except electrical)	1939	9,506	106,686	522,975	258,327,232	748,268,262	1,285,180,902	3,254,173,950
	1937	8,368	127,395	643,521	293,897,330	955,996,297	1,571,362,357	3,902,986,522
18. Automobiles and automobile equipment	1939	1,133	46,211	398,963	115,208,037	646,405,891	2,725,396,316	4,047,872,729
	1937	1,070	53,107	511,333	118,579,480	807,025,824	3,710,918,904	5,292,795,428
19. Transportation equipment except automobiles	1939	968	28,211	157,096	63,652,023	239,253,940	411,377,100	882,896,840
	1937	888	24,666	150,885	52,465,611	221,624,253	448,164,456	852,784,534
20. Miscellaneous industries	1939	7,699	37,641	238,827	92,312,311	258,325,273	469,167,316	1,162,958,308
	1937	6,311	40,738	239,804	90,565,065	260,452,100	442,966,593	1,077,572,584

[1] No data for employees of central administrative offices are included.
[2] The 1939 Census of Manufactures questionnaire, for the first time, called for personnel employed in distribution, construction, etc., separately from the manufacturing employees of the plants, and therefore, the data probably are not strictly comparable. It is not known how many of the wage earners and the salaried employees reported for 1937 were engaged in distribution and construction and how many were engaged in manufacturing. Employees of the plants reported as engaged in distribution and construction activities in 1939 are not included in this preliminary report but will be included in the final report.
[3] This is an average of the numbers reported for the several months of the year. In calculating it, equal weight must be given to full-time and part-time wage earners (not reported separately by the manufacturers), and for this reason it exceeds the number that would have been required to perform the work done in the industries if all wage earners had been continuously employed throughout the year. The quotient obtained by dividing the amount of wages by the average number of wage earners should not, therefore, be accepted as representing the average wage received by full-time wage earners. In making comparisons between the figures for 1939 and those for earlier years, the likelihood that the proportion of part-time employment varied from year to year should be taken into account. Also see footnote 2, above.
[4] Profits or losses cannot be calculated from the census figures because no data are collected for certain expense items, such as interest, rent, depreciation, taxes, insurance, and advertising.
[5] The aggregates for cost of materials and value of products include large but indeterminable amounts of duplication due to the use of the products of some industries as materials by others. This duplication occurs, as a rule, between different industries, and is not found to any great extent in individual industries.

PLASTICS, Cont.	1939	1937
Other plastics and synthetic resins,[2] value	$30,039,151	$13,568,113

[1] No data. [2] Includes synthetic rubber, photographic-film base, rubber substitutes, and ethyl cellulose. [3] Not including finished articles.

PULP

	1939	1937
Aggregate, tons	7,153,478	6,713,576
Value	$222,812,085	$242,443,451
Wood pulp, tons	6,993,334	6,572,918
Value	$209,061,107	$225,573,125
Mechanical, tons	1,444,875	1,600,667
Value	$27,710,170	$30,315,251
Sulphite fiber, tons	1,946,452	2,140,244
Value	$86,043,861	$109,920,115
Unbleached, tons	729,203	791,575
Value	$24,736,494	$30,718,426
Bleached, tons	1,217,249	1,348,669
Value	$61,307,367	$79,201,689
Sulphate fiber, tons	2,962,657	2,139,087
Value	72,939,469	59,437,736
Unbleached, tons	2,538,204	1,923,937
Value	$55,242,263	$51,096,623
Bleached, tons	424,453	215,150
Value	$17,697,206	$8,341,113
Soda fiber, bleached, tons	441,565	[2] 507,548
Value	$19,710,156	[2] $23,465,719
Semichemical and other wood pulp, tons	151,658	132,521
Value	$2,105,267	$1,748,316
Other pulp [3]	160,144	140,658
Value	13,750,978	16,870,326

[1] Includes data for "Superpurified" and "Rayon and special grades" to avoid disclosing figures for individual establishments for 1939. For 1937: "Superpurified" and "Rayon and special grades" combined, amounted to 353,640 tons, value at $23,871,039. [2] Bleached and unbleached. [3] Principally pulp made from cottonseed-hull fiber, cotton-linters, rag, reclaimed paper, and straw.

RAYON

	1939	1937
Aggregate value	$247,065,556	$251,942,457
Yarns, total production, pounds	329,374,048	321,680,725
Value	182,695,230	204,790,613
By process:		
Acetate, pounds	97,342,252	82,364,797
Value	$61,083,130	$55,533,198
Viscose and cupra-ammonium, pounds	232,031,796	239,315,928
Value	$121,612,100	$149,257,415
Rayon staple fiber, pounds	51,313,517	20,244,258
Value	$13,519,379	$6,177,471
Rayon waste,[2] pounds	12,599,852	11,185,338
Value	$1,465,382	$1,117,360
Allied products, value	[1] $49,385,565	$39,857,013

[1] Includes in order of value, transparent sheets, sausage casings, cellulose acetate, cellulose caps and bands, sponges, bottle seals, and other products. [2] Viscose and cupra-ammonium only.

REFRACTORIES

	1939	1937
Total value	$67,673,232	$82,009,835
Clay refractories, including refractory cement (clay), aggregate value	$40,400,738	$49,864,121
Fire-clay products:		
Brick, block or tile, except high-alumina, thousands	506,570	700,947
Value	$25,125,126	$32,806,495
High-alumina brick (over 40 per cent Al_2O_3), thousands	16,700	27,459
Value	$1,510,707	$2,133,675
Special shapes, tons	151,338	184,212
Value	$3,824,956	$4,750,779
Plastic fire brick, tons	43,664	44,011
Value	$1,118,974	$1,281,753
Ladle brick, thousands	59,783	67,401
Value	$1,575,189	$1,565,134
Refractory cement (clay), tons	52,866	57,927
Value	$2,499,828	$2,467,771
Other fire-clay products, value	$2,407,275	$1,548,437
Nonclay refractories, aggregate value	$27,272,494	$32,145,714
Graphite, crucibles and retorts Value	$1,666,976	$1,779,303
Other carbon, value	$378,678	$455,633
Magnesite and chrome brick, thousands	21,459	22,758
Value	$6,403,237	$6,726,943
Silica brick, thousands	173,382	220,110
Value	$9,019,478	$12,801,663
Silicon carbide refractory cement, tons	1,045	724
Value	$163,086	$142,939
All other non-clay refractory cement, tons	70,705	113,994
Value	$3,751,096	$2,132,061
Other non-clay refractories, value	$5,889,943	$8,107,172

RUBBER

	1939	1937
Boots and shoes, value	$40,446,140	$58,269,258
Tires and inner tubes, value	$497,636,438	$478,770,897
Reclaimed rubber, pounds	131,742,137	138,120,311
Value	$6,756,925	$7,758,292
Rubber products, not elsewhere classified, total value	$341,613,427	$333,642,556

SOAP AND GLYCERINE

	1939	1937
Aggregate value	$291,946,207	[1] $296,678,554
Bar soap:		
Toilet soap, pounds	405,083,669	360,610,753
Value	$64,919,683	$62,805,065
Laundry soap:		
White, pounds	660,766,458	488,979,981
Value	$29,837,998	$28,192,491
Yellow,[2] pounds	580,215,263	633,441,319
Value	$27,752,768	$33,195,616
Granulated, powdered and sprayed soap, pounds	894,727,289	743,194,783
Value	$75,631,820	$68,408,836
Soap chips and flakes:		
Packaged, pounds	284,143,533	274,275,994
Value	$24,984,799	$28,207,372
Bulk, pounds	135,071,434	116,179,494
Value	$9,582,030	$9,797,688
Washing powders:		
Packaged, pounds	133,638,514	146,924,947
Value	$5,506,608	$6,582,021
Bulk, pounds	114,703,458	85,486,294
Value	$3,331,965	$2,521,640
Cleansers and scouring powders containing soap:		
Packaged, pounds	167,441,482	157,039,241
Value	$6,948,037	$6,254,838
Bulk, pounds	18,708,354	21,307,024
Value	$796,336	$917,323
Glycerine: [3]		
Crude, pounds (basis 80%)	29,461,738	24,180,767
Value	$2,375,243	$3,592,537
Dynamite grade, pounds	64,293,972	43,586,391
Value	$6,595,283	$7,822,600
Chemically pure, pounds	90,484,348	78,813,063
Value	$9,512,106	$13,459,921

[1] Glycerine included in the Chemicals Not Elsewhere Classified industry for 1937. [2] Consumption of rosin used in the manufacture of Soap and Glycerine amounted to 75,401,813 pounds in 1939 and 75,450,320 pounds in 1937. [3] The total production of crude glycerine for 1939 was 184,476,395 pounds. Most of this was further refined and sold or used as glycerine dynamite grade, or glycerine, chemically pure.

BEET SUGAR

	1939	1937
Sugar, tons	1,634,442	1,296,210
Value	$125,822,984	$99,991,185
Molasses, sold or transferred to other factories for desugarization, tons	159,263	153,898
Value	$1,367,085	$1,161,272
Molasses, other than for desugarization, tons	89,832	93,786
Value	$826,313	$1,070,351
Beet pulp, tons	1,899,111	1,820,568
Value	$5,958,047	$5,048,978
Other products, value	$421,588	$123,750

CANE SUGAR REFINING

	1939	1937
Production, total value [1]	$384,412,492	$424,630,784
Refined sugar, hard		
Pounds	7,780,250,863	8,502,572,449
Value	$351,502,259	$395,142,101
Refined sugar, soft or brown		
Pounds	472,765,953	528,591,095
Value	$20,251,354	$22,603,146
Refiner's sirup, edible		
Gallons	3,428,277	2,735,498
Value	$827,915	$546,826
Sugar sirup		
Invert-sugar sirups of all densities, gallons	10,317,841	
Value	$4,456,980	7,029,582
Other sugar sirups, gallons	15,778,907	$2,618,646
Value	$5,011,900	
Refiner's blackstrap and nonedible sirup, value	$956,145	$1,399,024
Raw Sugar Treated, aggregate tons	4,403,639	4,722,660
Domestic, total	2,169,458	1,947,851
United States exclusive of outlying possessions	425,347	324,368
Hawaii	879,676	890,460
Puerto Rico and Virgin Islands	864,435	733,023
Foreign total:	2,234,181	2,774,809
Cuba	1,314,021	1,735,421
Philippines	859,936	924,302
All other	60,224	115,086

[1] No data for cane-sugar mills are included.

TANNING MATERIALS

	1939	1937
Aggregate value	$45,702,035	[1] $40,717,548
Tanning materials, value	$11,711,506	$10,864,720
Natural dyestuffs, value	$1,727,900	$1,407,500
Mordants, value	$179,345	$193,514
Assistants, value	$22,323,329	$17,841,344
Sizes, value	$9,759,955	$10,410,462

WOOD DISTILLATION

	1939	1937
Hardwood distillation, charcoal manufacture, and wood naval stores products, total value	$20,692,591	$26,877,762
Methanol (wood alcohol):		
Crude, gallons [1]	4,883,978	6,009,586
Made and consumed, gallons [1]	3,864,711	4,839,526
Made for sale, gallons [1]	1,019,267	1,170,060
Value	$178,174	$184,640
Refined, gallons [2]	2,958,644	3,967,561
Value	$796,803	$1,132,920
Acetate of lime, tons [3]	11,279	22,508
Value	$311,350	$720,730
Acetic acid, pounds [2]	53,855,475	49,204,347
Value	$2,544,623	$2,902,108
Methyl acetone, pounds	1,753,510	4,611,607
Value	$73,481	$180,745
Tar, total production, gallons	8,898,977	12,211,276
Made and consumed, gallons	3,502,785	4,073,363
Made for sale, gallons	5,396,192	8,137,913
Value	$831,207	$894,461
Tar oils, gallons	1,153,359	1,018,660
Value	$219,745	$209,448
Turpentine, wood,[4] gallons	8,249,370	8,723,503
Value	$1,774,065	$2,249,716
Pine oil, gallons	5,198,696	4,536,084
Value	$2,563,052	$2,395,364
Rosin, wood, barrels (500 pounds)	857,529	799,620
Value	$7,067,525	$10,400,478
Charcoal, bushels	24,910,005	27,461,211
Total value	$3,114,321	$3,824,145
Other wood derivatives, value	$1,218,245	$1,782,998

[1] Strength 82 percent. In addition, in 1939, 34,146,669 gallons of synthetic methanol valued at $9,319,752 were produced for sale in the "Chemicals not elsewhere classified" industry. Such production for 1937 amounted to 31,606,320 gallons valued at $8,619,238. [2] Strength 100 per cent. [3] Strength 80 percent. [4] Includes production in 1939 of 1,316,312 gallons valued at $131,777, by the wood-sulphate process. Production for 1937 amounted to 2,396,043 gallons, valued at $259,992.

COKE AND BYPRODUCTS

(*Continued from page* 110)

anticipated except possibly for household supply in a limited number of markets.

Two outstanding technical developments became commercially significant in byproduct oven practice during 1940. The addition of a small amount of oil to the coal charged has enabled production of larger yields of certain byproducts, notably toluene. And a number of plants are now returning fine coke to the charge, sometimes accompanied by oil and sometimes with higher than normal volatile matter in the coal mixture used. The fines so returned to the ovens become a part of the lump coke suitable for sale on the second trip through. In a number of cases this reduces by 50 percent or more the amount of fines that must be disposed of. The gross yield of large coke is, of course, correspondingly increased. The throughput of ovens is not significantly curtailed by either of these new methods of operation when they are practiced in moderation.

Significance of Ammonia in the National Defense

E. R. WOODWARD *Chemical Engineer, New York, N. Y.*

Chem. & Met. INTERPRETATION

Both government and chemical industries of the United States are fully awake to the need for a greatly expanded synthetic nitrogen industry. Ammonia nitrogen is much more versatile in its applications to both peace-time and military needs than sodium nitrate, and a domestic supply of the former places no such demand on shipping as does importation of the latter. The author, who has been associated for many years with the ammonia industry, and who participated in World War I as an officer of sappers, is well equipped to discuss the nitrogen requirements of military explosives and to show how ammonia nitrogen fits into the picture.—*Editors.*

Successful application of the Haber-Bosch process for the high pressure synthesis of ammonia in the year 1913, and subsequent exploitation of this and other synthetic ammonia processes following the World War, have had a profound effect on the explosives industry, particularly upon its military aspects. The effect upon world history is no less significant, for without the utilization of atmospheric nitrogen it is now acknowledged that in the World War Germany's munitions supply would have failed long before the actual termination of the conflict.

Today, ammonia is again in a dominant position. The explosives being used in largest quantities for charging airplane bombs, shells and other projectiles are ammonium nitrate and nitro compounds. The heavier bombs, weighing from about one-half ton to 2 tons, carry approximately 60 percent of their weight of high explosive; the lighter bombs, of 25 to 100 lb. weight, up to 50 percent. The proportion of high explosive to metal in airplane bombs is far greater than it is in artillery shells.

Looking at the chemical formula of ammonium nitrate, NH_4NO_3, it is evident that both radicals of this salt contains nitrogen, the first, ammonia nitrogen, the second, nitrate nitrogen. Ammonium nitrate contains 42.5 percent ammonia equivalent. The wartime importance of ammonia in this connection is therefore obvious, for ammonia can be oxidized to nitric acid and thus supply both radicals of the compound, while sodium nitrate, at one time the chief source of nitric acid, can supply only the last.

Synthetic ammonia production has long since passed in quantity that of byproduct ammoniacal liquor at coke ovens. This product, ordinarily containing at least 25 percent NH_3, may be stripped of its ammonia and the latter oxidized to nitric acid or used to neutralize HNO_3 in making ammonium nitrate. Nitric acid itself, formerly made by niter potting of sodium nitrate, is now made almost entirely by the oxidation of ammonia.

WORLD WAR EXPLOSIVES

During the World War, explosives used in shells and other projectiles did not vary greatly from those which are used for similar service today. However, on the Western Front, military mining was such a feature that it is interesting to call attention to the explosives used in that phase of fighting.

The high explosives most commonly used in underground warfare included wet guncotton, ammonal, blastine and gunpowder. As the war progressed, the consumption of ammonal (a British explosive) was ten times greater than that of any other high explosive used by the Allies in this service. The next in order of quantity was guncotton.

Ammonal—Ammonal used in the World War was a lustrous dark gray powder comprising a mixture of: TNT, 15 percent; ammonium nitrate, 65 percent; charcoal, 3 percent; fine aluminum, 1 percent; and coarse aluminum, 16 percent. The object of adding aluminum was to take advantage of the enormous amount of heat evolved by the oxidation of the powdered metal. The material was insensitive to blow or friction, but was very hygroscopic. Its explosive action was slower than that of guncotton, but higher pressures were generated provided the tunnel was well tamped.

Alumatol—This was used in the World War for filling bombs and hand grenades. Its composition was like that of ammonal except that the total aluminum content was only 3 percent, and it did not contain charcoal.

Amatol—Ammonium nitrate was first employed with TNT in 1914. After its safety had been proved through a wide range of conditions, it was adopted as an explosive under the name of amatol, a composition comprising various mixtures between 80 parts ammonium nitrate to 20 parts TNT, and 20 of the former to 80 of the latter. Although not so powerful in mines, it was used to some extent in place of ammonal to reduce the demand for aluminum, and was also used in shells.

Guncotton—Nitrocellulose, or guncotton, is prepared by the action of nitric acid on cellulosic materials such as purified cotton or wood pulp, and contains 12 to 13.5 percent nitrogen. This explosive was used for guncotton slabs, smokeless powders and as a bursting charge for submarine mines and for demolishing structures.

Blastine—This was a light brown powder comprising a mixture of: TNT, 11 percent; ammonium perchlorate, 60 percent; sodium nitrate, 22 percent; and paraffine wax, 7 percent. It was less hygroscopic than explosives of the ammonium nitrate group and less powerful for mines than ammonal.

Sabulite—This was used in the World War by the Belgians and was known as Belgian Permite. It was a dark gray powder, readily set off by service detonators, and made up of the following: ammonium nitrate, 78 percent; TNT, 8 percent; calcium silicide, 14 percent.

Trinitro Toluol—TNT is produced by nitrating toluol, which is a 1-deg. cut

of hydrocarbon light oil made from coal tar, or synthesized from petroleum. It is light yellow in color, insoluble in water, and does not attack metals. TNT is rather insensitive to blow or friction and may be used either as granules, or in a compressed, solidified form.

Gelignite—Gelignite is a high explosive containing nitroglycerin. It is used as an initiator for less sensitive explosives such as ammonal, also for blasting where cramming is necessary in rock crevices.

Picric Acid—Picric acid (trinitro phenol), a high explosive first adopted in 1886 by the French Government, is known as Melinite, and is called by the British, Lyddite. This compound melts at 122 deg. C. when pure and for explosive use is generally required to have a melting point of at least 120 deg. It may be manufactured from benzene by two processes, the phenol and the chlorobenzene processes.

Introduction of TNT as a military explosive has gradually eliminated the use of picric acid by all countries except France. The French forces used it in large quantities during the World War. In the United States it was used for conversion to "Explosive D," or ammonium picrate, which is used for base-fused shell for coast defense cannon. Picric acid has also been employed as a booster explosive, and as a substitute for a part of the mercury fulminate charge in detonators.

A disadvantage of picric acid is its corrosive quality. In contact with metals it forms picrates which are chemically unstable and decidedly sensitive to friction, shock or heat. Hence, shells to be charged with picric acid have to be internally coated with a cavity lacquer resistant to the action of the acid.

Studying the composition of the above explosives, it is noted that every one contains ammonia nitrogen, nitrate nitrogen, or a nitro compound. The ammonium nitrate content of some runs as high as 65 to 80 percent by weight of the complete explosive.

Many of the military explosives of today are simply those of the last war, but there are also some new ones. Among the nitrogen compounds, are the following:

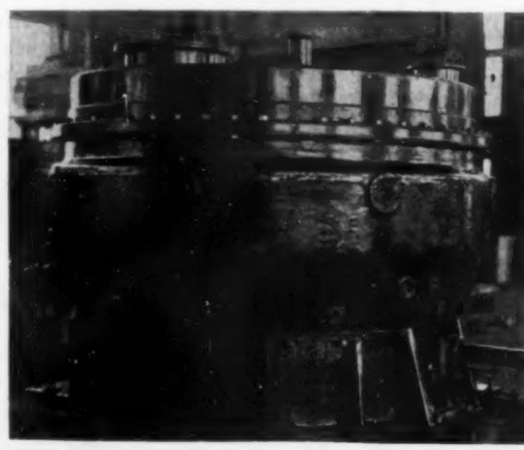
- Detonators and Fuses
  - Nitro mannite
- Propellants
  - Smokeless powder (nitrocellulose)
  - Cordite (nitroglycerine)
- Intermediate Detonators or Boosters
  - Tetryl (tetranitro methylaniline)
  - TNA (tetranitro aniline)
  - Hexyl (hexanitro diphenylamine)
- High Explosives (bursting charges)
  - TNT (trinitro toluol)
  - DNT (dinitro toluol)
  - Amatol (various mixtures of ammonium nitrate and TNT)
  - Explosive D (picric acid and ammonium picrate)
  - Trinitro anisol
  - Penthrite (pentaerythrite tetranitrate)
  - Nitrostarch

AMMONIUM NITRATE

An ammonium nitrate explosive was patented in Sweden as early as 1867, and in the next few years several types were developed, such as a mixture of ammonium nitrate and dinitro benzol. Varying proportions of these ingredients were used for different types of work such as coal mining, quarrying and submarine tunnelling. In early methods of manufacture, the combination of ingredients represented the last stage of the process before making the explosive up into cartridges. At a later stage of development, uniform practice was to dry and combine first. Sufficient heat was supplied to melt the nitro compound, which was allowed to cool, and then it was worked cold throughout the rest of the process. By this means the explosive was kept in a finely divided state.

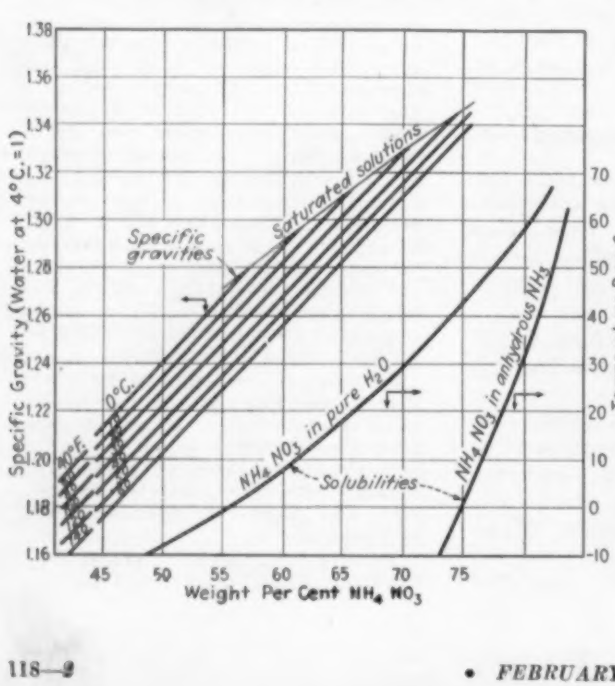
The affinity of explosives for moisture, and the varying degrees to which different nitro compounds resist absorption of moisture, are well known. By maintaining uniform

Right—New type of 450-gal. ammonium nitrate graining kettle built by Buffalo Foundry & Machine Co.: larger than earlier kettles. it features several improvements



Lower Right—Size of ammonium nitrate crystals can be controlled within close limits as shown by these two samples. both reproduced at a magnification of eight (Hercules Powder Co.)

Below—Properties of ammonium nitrate solutions of varying concentration are shown in the accompanying graph of specific gravity against concentration, and solubility against temperature



conditions of temperature and moisture during manufacture, the resultant explosive will be more uniform in action, and definite standards of strength can be assured.

Early types of nitrogen explosives were made in a semi-plastic condition, consisting chiefly of salts such as nitrates or chlorates, mixed with a small proportion of a nitro compound such as nitrated benzol, toluol or naphthalene. Today the ingredients of these mixtures are prepared in a finely divided state, mixed and heated to a temperature above the melting point of the nitro compound. As the whole mass is thoroughly agitated, the grains of salt are coated with the fused ingredient, and while still hot the mixture is sufficiently plastic to be formed into cartridges.

Generally speaking, minute quantities of substances containing available oxygen, for example chlorates and most nitrates, in contact with nitro compounds such as trinitro toluol, greatly increase the sensitiveness of these compounds to heat or percussion. Ammonium nitrate, however, is almost the only substance of this class capable of being safely employed in admixture with TNT. Such a mixture is safe to handle or transport. Ordinary fire or shock will not cause ignition.

That ammonium nitrate is extremely important as a base for military explosives is shown by the expensive methods of manufacture which were used during the World War before ammonia synthesis had been perfected outside of Germany. The following methods were used in England:

1. From Sodium Nitrate — Brunner Mond & Co. patented a process for the manufacture of ammonium nitrate along lines similar to this company's ammonia soda process. The method consisted in ammoniating a strong solution of sodium nitrate and blowing carbon dioxide gas through this to obtain bicarbonate of soda as a precipitate, and ammonium nitrate in solution. The solution, after separation, was cooled to deposit solid ammonium nitrate.

2. From Sodium Nitrate and Ammonium Sulphate—New works for the operation of this process were erected at Swindon, England. From the start of production in September 1917, to the cessation of hostilities in November 1918, this process produced 23,000 tons of ammonium nitrate.

3. From Calcium Nitrate—Brunner Mond & Co. devised a suitable process and undertook the conversion of calcium nitrate to ammonium nitrate. Some thousands of tons per month of 70 percent calcium nitrate were so converted.

The modern method of manufacturing ammonium nitrate is by the direct interaction of ammonia and nitric acid. Ammonia gas is introduced into a saturator beneath the surface of a body of ammonium nitrate solution contained therein. Nitric acid of 40 percent concentration is fed to the saturator. The heat of reaction of the combining material causes the solution in the saturator to boil and become partially concentrated by vaporization of water introduced with the acid.

At the powder plant, ammonium nitrate is stored in aqueous solution varying in strength from 45 to 68 percent NH_4NO_3. It is fed from the storage tank by gravity to the high-pans which are fitted with stainless steel or aluminum heating coils. In these open pans the solution is evaporated down to about a 2 percent water content, then flowing through piping into the graining bowls. Here it is stirred by slowly revolving stainless steel paddles until the grained ammonium nitrate is dried to 0.10 percent moisture. A coating compound, sometimes consisting of 80 percent rosin and 20 percent petrolatum, is added to the ammonium nitrate in the graining bowls. This coating waterproofs the grains and prevents caking.

Grain size is controlled by temperature and rate of precipitation. An example of the variation in grain size which may be obtained by proper control will be evident from the two accompanying views which were both photographed at the same magnification (8x as reproduced). Grain size is important in determining the rate of flame propagation in an explosive. Research, manufacturing experience and field tests enable the manufacturer to determine the correct size to use in various grades of explosives.

As delivered at the powder plant, ammonium nitrate may either be in the dry form or in solution in water. The water solution is specifically known as ANW. It has become common practice in the United States to ship 50 percent ANW solution during the winter months and 55 percent ANW solution during the summer. Recently, however, 75 percent ANW solution has been shipped throughout the year in order to save freight on water. In a typical example, a saving of $54 per carload was realized. Under these conditions, however, the unloading operation is rendered more difficult by a deposit of about 4 ft. of solid salt in the car when it reaches the customer's plant in cold weather. The salting-out temperature of 75 percent ANW solution is 108.5 deg. F. (42 deg. C.) as is evident from the accompanying solubility chart. As the cars used for such shipment do not contain steam coils, the supernatant liquor has to be well steamed at the receiving point and agitated with air before the solid salt can be removed.

NITRATION

Many nitro compounds (organic compounds containing the $-NO_2$ radical combined with the carbon atom) are employed as explosives, generally in admixture with other material. One of the best known is TNT (trinitro toluol) which will serve as a good example of nitration.

The nitration of toluol is accomplished with a mixture of nitric and sulphuric acids and is carried out by a one-, two-, or three-stage process, the last of which is now most used, since it is the most practical and economical. This process produces successively mono-, di-, and trinitro toluol. First, mono spent acid is run into the nitrator to provide a weak charge as a bottom layer and prevent the loss of HNO_3 from the nitrating acid, and possibility of a charred product. This step employs one part of toluol to 0.9 part HNO_3. Agitation should be slow enough to prevent mixing of the toluol with the acid.

In the second stage the mono product is further nitrated to the di material using a fortified acid made by adding fresh nitric acid to spent acid from a previous trinitration. The temperature gradually rises to 83 deg. C. where the batch is held for completion of the nitration. The third stage, which is the most difficult one, requires very strong acid to complete the nitration of the di to the tri product. This stage is carried out at from 85 to 104 deg. C. and is continued until the solidifying point of the oil produced is 72 deg. C. or higher.

AMMONIA SUPPLIES

The importance of adequate supplies of ammonia in wartime is amply demonstrated by the facts which have been presented above. In 1914, the world production of synthetic ammonia was negligible. Today the annual world capacity exceeds 3,910,000 tons. Thus synthetic production has far outstripped that of byproduct ammonia. It is self-evident that

synthetic ammonia plant capacity is the dominating factor in the production of military explosives.

An instructive comparison can be made on the basis of estimates of world synthetic nitrogen capacity. In 1937 Germany's installed capacity, in short tons of synthetic ammonia, was 1,375,000. In the same year Japanese capacity was 264,000 tons and Italian capacity was 150,000 tons. The total for France, Belgium, Netherlands, Norway, Poland and Czechoslovakia was 986,000 tons. Therefore, even assuming no increase in capacity since 1937, the synthetic ammonia capacity of countries now dominated by the Axis amounts to a total of 2,775,000 tons, leaving but 1,135,000 tons of capacity for the rest of the world.

With these figures showing the Axis powers controlling more than twice as much synthetic capacity as all the rest of the world combined, it is evident why there is urgent need to increase the production of ammonia among non-Axis countries. It is equally clear why new synthetic ammonia plants are at present being built in the United States and old ones are being reconditioned.

German Ammonium Nitrate

KARL FALK *Fresno College, Fresno, Calif.*

Chem. & Met. INTERPRETATION

Ammonium nitrate, since it is of some little interest as a fertilizer ingredient, and is certainly important as a high explosive in combination with TNT in proportions up to 80 percent of the mixture, has been the subject of much recent work in Europe. Dr. Falk here describes briefly new processes that have been developed in Germany, while the short article on the following page summarizes a new Italian process which may have merit.—*Editors.*

New processes to make ammonium nitrate to replace ammonium sulphate, whose production requires imported raw materials for H_2SO_4, are among the latest wartime chemical developments in Germany. Heretofore, besides potash, ammonium sulphate has been the Reich's chief fertilizer export item, and almost all coke oven ammonia gas has been converted into this product. Five hundred thousand metric tons of sorely needed H_2SO_4 have been used annually in Germany to produce ammonium sulphate from coke gases, making this industry the largest single sulphuric acid consumer.

Interruptions during the Spanish Civil War in the supply of Spanish pyrites, chief raw material for German H_2SO_4 production, stimulated efforts in the Reich to develop domestic sources of sulphur and acid and led to new methods of recovering sulphur from coke ovens and synthesis gases, and more recently to utilize anhydrite (see *Chem. & Met.*, May 1940, p. 333). New processes were also introduced to use sulphur contained in coke-oven gases for producing ammonium sulphate in one continuous action. Successful experiments have been made to dispense with acid as a disintegrating agent in the manufacture of phosphoric fertilizers. Now it is planned to replace sulphuric acid with domestically available nitric acid to produce ammonium nitrate instead of sulphate from coke-oven gases.

It is contended—whether or not this is wartime rationalization remains to be seen—that valuable sulphuric acid heretofore has been used only to bind the nitrogen and is therefore not fully utilized, and that sulphates cause a less desirable acid condition in the soil than nitrates. Ammonium nitrate produced through neutralization, it is claimed, can be more completely absorbed by plants than sulphates, and, what is probably more important, can be produced entirely from domestic raw materials.

An unusual amount of research was required to solve the problem of replacing sulphuric acid with nitric acid in treating coke-oven ammonia gases to prevent undesired reactions of impurities in the gas, notably H_2S, with the nitric acid. Oxidation of H_2S to SO_2 and H_2SO_4, and reduction of HNO_3 to nitrogen oxides, caused considerable losses of acid in the process. Thus the use of nitric acid to bind coke amomnia was possible only if the side reactions could be eliminated or held to a minimum. Experiments with varying concentrations of nitric acid and various temperatures indicated three possible procedures: (1) neutralization below 90 deg. C.; (2) removal of H_2S from gases and neutralization above 90 deg. C.; and (3) addition of oxidation preventives and neutralization above 90 deg. C.

The first method, namely, neutralization below 90 deg. C., is only a compromise solution since the undesired concurrent reactions cannot be completely eliminated. The speed of reaction between H_2S and HNO_3 can be retarded, however, so that the loss of nitric acid remains within reasonable limits (10 percent loss at 118 deg. C., 5 percent at 70 deg. C., but only 1.61 per cent at 90 deg. C. if acidity of the solution is reduced to the neutral point). In order to utilize neutralization heat for the vaporization of water brought in with the acid, the process must be carried out in vacuum, however.

The second method calls for removal of H_2S from the ammonia-containing gas mixture and neutralization above 90 deg. C. Desulphurization can be accomplished in three ways: (1) absorption of H_2S by lime; (2) conversion to ferrous sulphide by action of iron and H_2S; and (3) driving H_2S out of ammonia water by means of a carrier gas, and later processing the H_2S further (Claus oven or Lurgi process) to sulphur or H_2SO_4. This procedure is suitable when ammonia is concentrated beforehand—although it is not absolutely essential—and brought to a central nitric acid producing plant for final conversion into ammonium nitrate.

Although the second process eliminates most of the losses of nitric acid, it still has the disadvantage of being practicable generally only where central processing of concentrated ammonia water is possible. In many cases it is desirable to make ammonium nitrate directly in the coke plant. To prevent undesired reactions between the H_2S and HNO_3, an ammonium phosphate negative catalyst added to a slightly acid ammonium nitrate solution in the scrubbing tower has been found satisfactory. An addition of phosphate equivalent to 15 to 20 grams P_2O_5 per liter of solution eliminates oxidation almost completely. The behavior of prosphoric acid is based on its repression of concentration of free nitric acid

according to the equation $HNO_3 + NH_4H_2PO_4 \rightleftharpoons H_3PO_4 + NH_4NO_3$, and upon the removal of ionizable iron salts which are always present in the saturator and would otherwise catalytically stimulate undesired interaction between H_2S and HNO_3. This process has proven the most practical of the three, since it yields an almost pure white salt from crude 1 percent ammonia solutions, and works with almost no loss of nitric acid.

The three described processes call for using nitric acid obtained from outside sources. Through a new fractional distillation process as diagrammed below, nitric acid can also be produced by oxidation from either diluted or concentrated ammonia water directly in the coking plants themselves.

Ammonium Nitrate in Italy

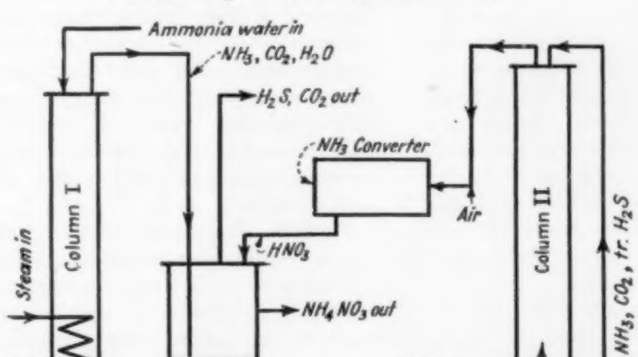
Ammonium nitrate, except in war times, has been of more interest in Europe than in the United States, probably because of its extensive use in European countries as a fertilizer ingredient. On this account foreign engineers such as Giacomo Fauser, well-known Italian chemical engineer, have devoted a good deal of work to the efficient production of this salt. On page 591 of the September 1930 issue of *Chem. & Met.*, Fauser pointed out that if the considerable heat of reaction between ammonia and nitric acid is to be used in concentrating ammonium nitrate solutions, then it is necessary to operate under pressure since the boiling point of nitric acid is less than that of the ammonium nitrate solution obtained and at atmospheric pressure considerable nitric acid would be lost as nitrous fumes. In the process described at that time, Fauser carried out the reaction between preheated ammonia gas and a nitric acid solution within a closed vessel under a pressure of 8 to 9 atmospheres. The ammonium nitrate solution was then throttled to atmospheric pressure and the steam evolved used to preheat the nitric acid and ammonia. Pumps were required for raising the pressure of the raw materials to the working pressure.

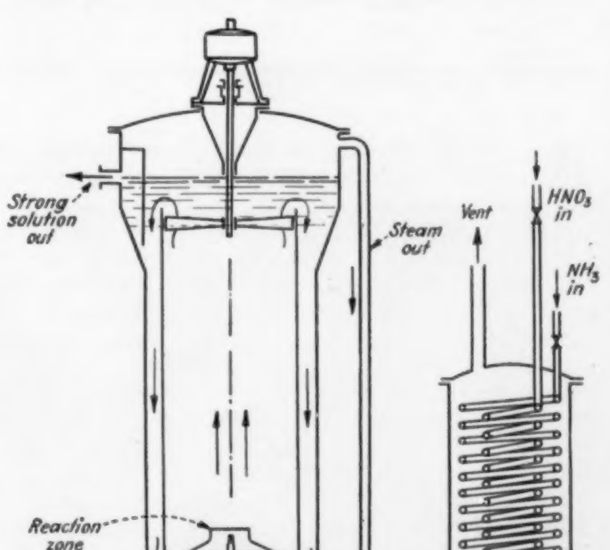
About ten plants in Italy and in various other countries have been operating on this process, with a total daily output capacity of 600 tons of ammonium nitrate, and at pressures somewhat lower than originally specified, namely, 4 to 6 atmospheres. Recently a still later process developed by Fauser has been described in the Italian literature. This process eliminates the pumping of the nitric acid and ammonia, carrying out the reaction under sufficient hydrostatic head to prevent boiling in the reaction zone. In producing a concentrated solution, experience has shown that by maintaining a free alkalinity between 0.3 and 0.5 grams ammonia per liter, the loss of nitrogen is less than 1 percent. The alkalinity helps also to prevent corrosion.

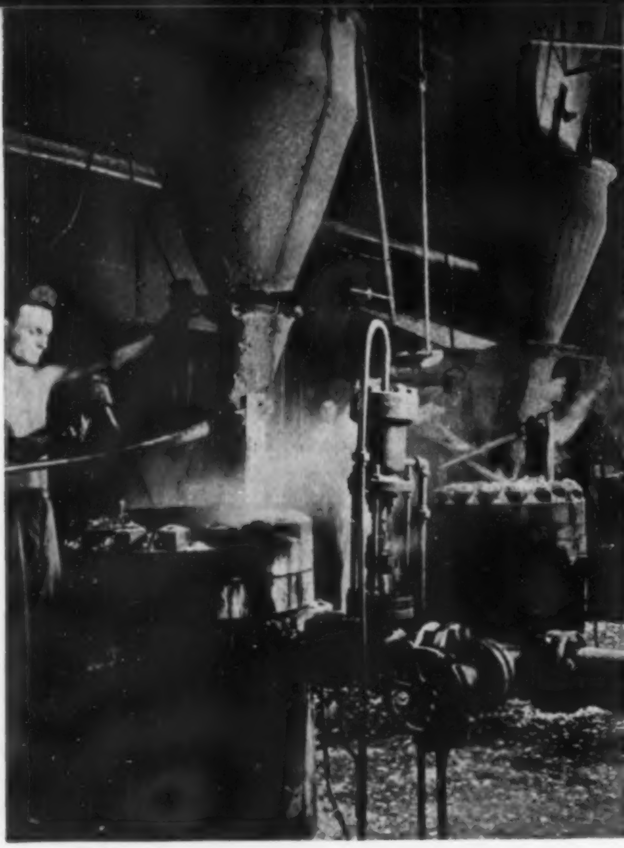
The saturator used in this latest modification must be tall enough to give the desired hydrostatic head, as shown in the accompanying sketch. Ammonia and nitric acid are led into the equipment through pipe coils where they are preheated by steam from the saturator. Ammonia is admitted through a ring distributor beneath a conical baffle, with nitric acid admitted centrally from a somewhat higher jet. In producing a 90 percent concentration from 56.2 percent nitric acid, a liquid column of 4 meters above the reaction zone is necessary to prevent boiling. The boiling point of this solution is 147 deg. C. and the excess pressure at the bottom of the column of liquid is 0.55 atmosphere. Upward circulation of the ammonium nitrate solution is maintained by a paddle agitator which also creates downward flow through the annular space between the reaction cylinder and the outer vessel. Steam equivalent to the heat of reaction is evolved at the liquor surface, passing out to the preheater. Concentrated ammonium nitrate solution flows continuously from a lute, passing to a crystallizer (not shown) which Fauser has developed to permit further concentration and crystallization of the 90 percent solution from the saturator, by means of hot air, without additional steam. For agitating and air handling, the power consumption is about 20 kw.-hr. per ton of ammonium nitrate produced.

At Right—Diagrammatic sketch of Fauser "hydrostatic head" saturator for ammonium nitrate manufacture

This flow diagram shows the main outlines of the new German process whereby dilute ammonia liquor at the coke plant is converted in part into nitric acid for reacting with the remainder to produce ammonium nitrate







Guns for exploding wood chips at the plant of the Masonite Corp. Pressures to 1,000 lb. are used

EXPLOSION Unit Operation of the Process Industries

DOUGLAS MEIGS

*Research Fellow, Dept. of Chemical Engineering Illinois Institute of Technology**

Chem. & Met. INTERPRETATION

During the last twenty years explosion has been increasing in importance as a unit operation of the process industries. It is being used for size reduction, modification of substance and for separation of components. Rubber reclaiming, manufacture of fiber board, and the familiar puffed cereals are examples of industries which use this operation. Applications and machinery have been studied extensively at the Bureau of Mines and elsewhere. Mechanical difficulties and costs have prohibited more widespread use. These drawbacks are being corrected by continuing study.— *Editors.*

As an important tool of modern warfare, explosion drives the vehicle of destruction, it forces the projectile from the cannon's mouth, and it bursts the shell in the face of the enemy. Yet, within the last score of years explosion has acquired another role. It is now a unit operation of the process industries and accordingly falls under the scope of the chemical engineer along with distillation and heat transfer. The various applications may be classified according to primary purpose, falling into three groups: particle size reduction, modification of substance and separation of components.

* Present address, 3309 Glen Avenue, Baltimore, Md.

The process of disintegrating by explosive force, and in particular, the splitting of mica, was patented by Bancroft in 1921.[1] Replacing the tedium of splitting crude mica by hand, the invention utilized a pressure-tight cylinder in which the water-soaked material was heated to some desired pressure, at which it was suddenly released. The explosive effect split the thick pieces of mica into thin leaves suitable for preparing laminated insulation.

Bancroft's patent mentioned the explosion of wood, but his claims were limited to the generating of steam within the cylinder and to releasing pressure by opening wide one end of the cylinder thus effecting a nearly simultaneous pressure drop throughout the charge.

In 1926 Mason patented a process for exploding wood chips to prepare a product suitable for direct refining to paper or fiber board.[2] Operating at 400 to 600 lb. steam pressure, the apparatus was equipped with an external boiler. After the wood had been thoroughly softened and impregnated with steam, balancing internal and external pressure on each chip, a small valve was opened at one end of the cylinder and while maintaining pressure within the latter, the wood was permitted to escape through the valve. External pressure on each chip dropped as it passed thru the valve and the unbalanced pressure exploded the chip.

A later modification involved preliminary soaking of the wood with steam at 100 lb. pressure, subsequently reinforced with compressed air at more than 400 lb. pressure.[3] This practice prevented the discoloration of the wood which occurred whenever steam of greater than 350 lb. was used.

Further technical improvements related to the manner of controlling steam input and product discharge.[4] These were followed by the development of equipment using a continuous high-pressure feed screw and preheater.[5] By materially shortening the time of contact, it was possible to use higher steam pressure (1,000 lb.)

without charring the pulp, a thermodynamically sound economy. The continuous process decreased steam wastage, yielded a uniform product and required a minimum of manual attention.

As can be imagined, the development of a screw-feeding device to operate against such high pressure was no easy problem. As yet the commercial operations are using the earlier batch equipment because the continuous process, although technically successful, did not justify scrapping the existing methods. An indication of the capacity of the batch explosion guns is to be had from the statement that a daily production of about a million and half pounds of disintegrated wood is attained with a dozen guns, varying in size from 12 to 26 cu. ft. each.[6]

The work of Dean, Gross, and associates of the U. S. Bureau of Mines on explosion shattering of ores has been published more or less continuously.[7] A series of explosion shattering machines was tried, leading to the development of an intermittent machine operating on a hand-controlled cycle. Steam pressure within the cylinder was sealed by an inverted poppet valve and release was obtained by a trip cam controlling the tension of a heavy retaining spring. Discharge of the entire contents of such a cylinder would be nearly instantaneous with sufficient valve movement. Data have been obtained on the effects of pressure and temperature, time of soaking, water to charge ratio, size of charge and type of impact. In general, the degree of comminution was found to increase more or less linearly with pressure. Size of charge was found to have an effect and impact proved to be an important factor.[8]

A series of investigations on various ores showed that preferential shattering of components occurred to a greater extent with explosion than conventional methods of crushing and grinding, although in some cases the effect was not great.

An economic study of the operation showed that restriction of the steam supply decreased the cost per ton of fines, but also decreased the capacity of the equipment. Increasing steam pressure from 150 to 250 lb. decreased the cost per ton by about one-quarter. No higher pressures were studied at the time of the report. It was concluded by Gross that high pressure, short soaking time and larger charges would be desirable for greater economy. Dean states that subsequently pressures as high as 5,000 lb. have been investigated, and while the results were not conclusive, they indicated that such high pressures were not economical.[9]

Since the transfer of the bureau's experiments on explosion shattering from the University of Minnesota station to Salt Lake City, new equipment has been placed in operation having a capacity of about 100 cu. ft. per hr. Provided with an external steam boiler at 250 lb. pressure and fully automatic controls, the machine utilizes an ingenious linkage for opening and closing the cylinder at both ends on a cycle of 10 seconds.[9]

Cost figures have been determined on the crushing of limestone in this equipment. While only approximate, they are given here to indicate the present status of the problem.

Cost of Crushing Limestone[10]
Cents per ton of –200 mesh product

Operation	Steam	Electricity	Total
Explosion			
max. capacity..	37.6	9.5	47.1
max. efficiency..	6.6	23.7	30.3
Discontinuous jet			
max. efficiency..	19.8	2.3	22.1
Ball mill.........	....	12.3	12.3

Compared with the ball mill, it is evident that explosion shattering can be used advantageously only if the electrical requirements to operate the valve linkage can be reduced to 20 percent of the present figure when the steam efficiency is a maximum. This presents a difficult but not insurmountable obstacle, and is largely a problem of ingenuity and sound mechanical engineering. The discontinuous jet is a development of the work of the Bureau of Mines on nozzle crushing,[11] and is expected to receive further refinement.

The explosion of coal was investigated at some length by the Research Foundation of Illinois Institute of Technology,[12] and the following variables were found to be significant:

A. Independent variables
1. Substance being exploded
2. Explosion medium
3. Maximum pressure
4. Rate of pressure drop
5. Time of soaking
6. Temperature
7. Number of previous explosions
8. Impingement
9. Moisture content
10. Size of feed

B. Results
1. Screen analysis
2. Ash distribution in products
3. Volatile matter
4. Grindability
5. Sulphur content
6. Heating value

Tests upon different samples of Illinois coal showed different susceptibilities, although the variation was small compared with the differences in effect upon substances typical of the impurities in coal, such as pyrites and bone. It is expected that other types of coal would behave differently from Illinois coal.

Steam and air were compared as explosion mediums. While steam was found to be superior to air, excess water interfered with the explosion. Use of air with an auxiliary heater permitted comparison of the two mediums at the same pressures and temperatures. It was not determined why steam was better than air. A possible reason might be that the volume change of water would be greater than air for the same pressure drop.

Pressure seemed to be the most important factor. It was found that the amount of size reduction, as indicated by the increase of the surface factor "S," was more or less linear with the pressure used. In general, the effect of increased pressure be-

At the Laurel, Miss., plant of the Masonite Corp., exploded wood fiber from the guns is separated from steam in large cyclones

came slightly less at high pressures.

When air was used as the explosion medium, the temperature was found to be important, probably due to a softening effect upon the coal. Thus, increasing the temperature from 65 to 500 deg. using 2,000 lb. pressure, increased the amount of size-reduction about six-fold. Lack of time prevented a study of the effects of using superheated steam. It is believed that increased pulverization might thus be accomplished, but with sacrifice of the burning qualities of the product since high temperature seemed to reduce the volatile matter content of the powdered coal.

The time of impregnation was studied, using steam, but owing to the cumbersome operation of the equipment it was impossible to determine the minimum period. Any time greater than two minutes seemed to have little effect upon product size, reducing the amount of pulverization, if anything.

Rate of pressure drop would seem to be important since this controls the maximum difference between internal and external pressure for a particle. However, the effect was not proven quantitatively. Two different types of explosion chambers were used, one rupturing a steel diaphragm for maximum abruptness and another using a hydraulic piston to seal the cylinder mouth, a more practical design from the standpoint of commercial operation. The results of this comparison showed only a slight improvement with the bursting diaphragm, not far beyond the limit of experimental error. However, the effect might be shadowed by a decrease in impingement. Another possibility is that since the piston apparatus opened only about 3/16 in. perhaps the greatest pressure drop occurred in the space between the piston and the cylinder mouth. Indeed it was found that leaving the steam valve open during explosion increased the amount of shattering, although it surely decreased the rate of pressure drop. The unsolved question is whether this effect was the result of increased impingement or maintenance of the steam pressure within the cylinder for maximum pressure drop at the orifice.

No quantitative data were obtained in the explosion of coal on the effect of impingement. It was recognized as an important unknown quantity in the comminution process.

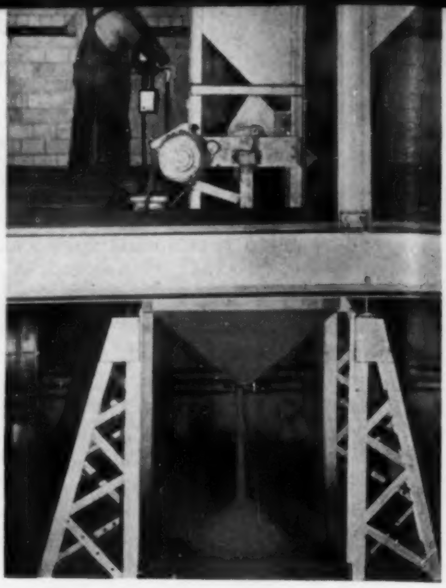
The surface factor "S" mentioned above, was introduced as a means of putting all results on a comparative basis. S is defined as the reciprocal diameter of the average particle size of a fraction graded between limits. It will be seen that the amount of surface area per unit weight of material is proportional to this factor, and according to Rittinger's law, this indicates the efficiency of size reduction. Average S for a wide range would equal the sum of the products of the individual S's times their respective weight fractions. The degree of pulverization in any test would be measured by the difference between product S and feed S.

MODIFICATION OF SUBSTANCE

Everyone is familiar with the pastime of corn-popping; although few people will think of it as being related to chemical engineering. Yet, as a means of modifying a physical structure by explosion, it is an indisputable example. During the heating of the kernels, their horny surface retains the internal moisture until pressure exceeds the breaking point of the skin. With rupture of the latter, the cells are free to expand, giving the dry, fluffy and succulent product. Inspection of a piece of popcorn shows that the skin fragments adhere to the cellular structure, which has turned inside out in the course of explosion.

The process of exploding grains, leading to the commercial production of puffed wheat and puffed rice as breakfast cereals, was originally developed by Anderson. An early patent[13] described as a new article of manufacture, a hulled, swelled and spongy cereal grain (rice), having its starch granules disrupted and their remains contained in water-soluble cell-walls of a new pith-like structure. Substantially the original shape of the grain is preserved and is dotted over the surface with the remains of the original inner coating. The treatment consisted of heating air-dry grain to above the normal boiling point of water in a closed vessel and then suddenly releasing the pressure by opening said vessel.

The process was found to apply equally well to artificial grains of starch or flour, provided they were tumbled and heated while moist, to form pellets with a gelatinized surface and suitable moisture content.[14] Operating conditions naturally vary for different charging stocks, but 130 lb. steam pressure is specified by one patent[15] for the explosion of starch pellets, with 10 to 50 lb. given elsewhere as the impregnating steam pressure in the tumbling stage. Equipment developed by Anderson consisted essentially of a steel drum with a heavy gasketted cover for one end. The cover was attached with a slot-and-pin hinge and held by a sort of a trigger closure. Where necessary to tumble the charge, the drum was made rotatable with a packed gland on the steam pipe and projections within the cylinder to break up the charge. Explosion cylinders used for the puffing of grain are smaller than those used for disintegrating wood, being four to eight in. in diameter and 18 to 30 in. long. The operating cycle is considerably longer, usually requiring from 8 to 15 minutes. Capacity of the 6x24-in. equipment is given at 2½ tons of grain per gun per day.

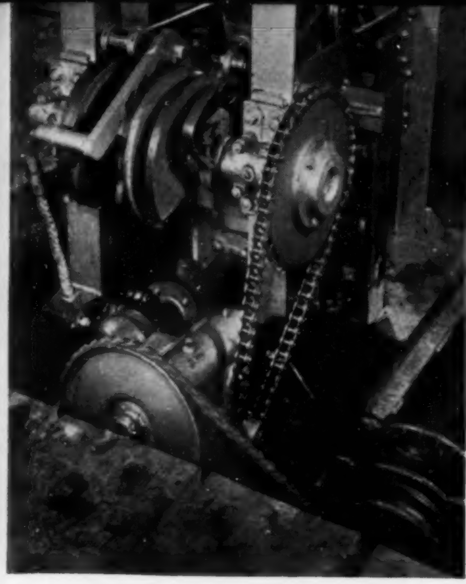


Rock-shattering machine at the Bureau of Mines. The explosion chamber is a steel cylinder eight inches in diameter

Another application appears in the reclaiming of rubber. It has been found that explosion of the scrap rubber with steam has been effective in devulcanizing and disintegrating it preparatory to reworking. Gross[17] patented such a process (refined and further developed by Palmer[18]) to replace existing methods which involved either expensive solvents or treatments of long duration.

Hogged rubber scrap is subjected to high pressure steam for a period of time sufficient to soften and impregnate the mass; then pressure is abruptly released. The product is a mass of plastic, devulcanized particles which are directly suitable for further milling and compounding. Any fiber content has been sufficiently hydrolized and disintegrated as not to interfere with further treatment. Sulphur content is transformed in effect from the free to the combined state.

Depending on the size and nature of the charge, conditions vary in the range of 300 to 1,000 lb. steam pressure and a one to 30-minute treatment. Typical conditions as used at the present time are given as follows:[19]



Details of the machine shown on page 124. Cam-actuated arms automatically control the rock shattering operation

Passenger inner tube scrap, 3 minutes at 500 lb.
Bus inner tube scrap, 6 minutes at 700 lb.
Pneumatic scrap, 5 minutes at 700 lb.
Solid tire scrap, 8 minutes at 800 lb. pressure.

Equipment is almost identical with that used for the disintegration of wood and has a capacity of from 15 to 25 tons per gun per day.

Explosion has been considered as a means of tenderizing meat. In 1939 some experiments were conducted at the Research Foundation of Illinois Institute of Technology which indicated that such a procedure might be feasible and would merit further study. Further developments are open only to conjecture at present; to the writer it seems probable that any explosion used would have to be of controlled intensity to avoid destruction of the meat.

SEPARATION OF COMPONENTS

A means of separating the hulls and germs from whole kernels of maize by explosion was patented in 1911 by Anderson.[20] The process involved heating air-dry Indian corn to about 187 deg. C. in a pressure tight vessel, then suddenly releasing the pressure. The corn was discharged from the vessel and the hulls and germs were blown off by internal pressure. The remaining product was a swelled, dry, spongy grain, resembling the more familiar puffed rice in its water solubility and other characteristics.

Using a different technique, a method of shelling walnuts by explosion has been developed by Bainer and Barbee, of the Division of Agricultural Engineering of the University of California.[21] The nuts are held between rubber belts and passed over a small circular saw which slits their shells. Then they are impregnated with an oxyacetylene mixture and chuted thru a flame which ignites the gas. The resulting explosion throws the shells off. Fragments of the latter are thrown outward and away from the nut meats which are collected comparatively undamaged in a receptacle beyond the flame.

The machine has a capacity of about 10 tons of nuts per day with the belts moving at 110 ft. per minute, according to the inventors. Approximately 60 percent of the nut meats come out in whole or half pieces, and very few small chips are produced.

THE GENERAL PICTURE

It appears that in spite of differences in materials and effects, the basic explosion processes are much the same, differing chiefly in degree. Thus the applications of particle size reduction may be listed in the order of increasing importance of impact crushing. In the splitting of mica, impact effects are detrimental to the product and may be avoided by making the opening to the pressure drum and the length of the receiver both as large as practicable. In the disintegrating of wood, the material is sufficiently resilient that impact of the expelled particles is of little importance, but some tearing of the chips will take place as they are extruded through the expansion valve. Impact crushing assumes some importance in the pulverization of coal by explosion because the material is dense and more brittle than wood. And when working with relatively impervious and crystalline ores, the effects of subsequent impingement may become more important than the explosion itself as a means of shattering the rock.

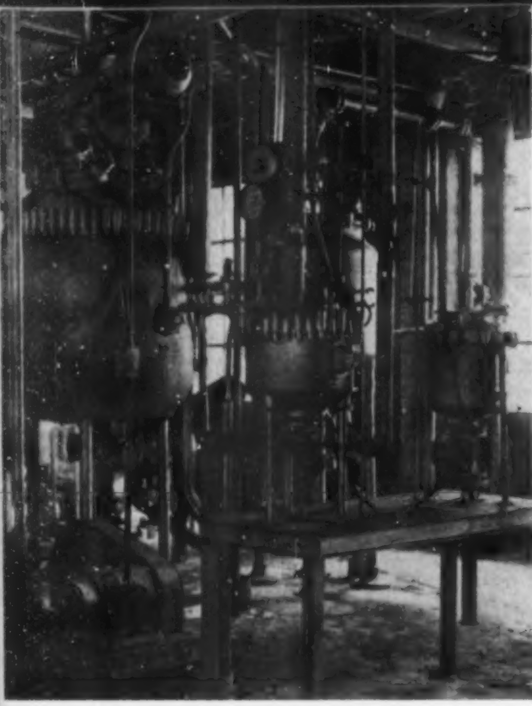
In the separation of components, explosion is utilized without impingement because the latter has little if any effect. Here appears the only application of pure explosion, i.e., a reaction liberating energy more rapidly than it can be taken care of. Here time of contact is important. The writer conducted some experiments at the Research Foundation on the explosion of nuts by steam, but in the course of impregnation of the shells with the necessary pressure, the nut meats were rendered unpalatable. With the acetylene explosion, the shell is blown off before the meat is damaged by the high temperature. There is little difference in principle between blowing the shells off walnuts and dehulling Indian corn, yet the techniques do not have much in common. This leads to the logical conclusion that perhaps even different techniques are yet to be developed by the ingenuity of the engineer.

More closely resembling the process of dehulling Indian corn is that of making popcorn, which comes under a different classification since only modification of the substance is sought. Other processes falling in this group, the puffing of cereals, tenderizing meat, and reclaiming rubber, have a common characteristic in that conditions must be controlled to avoid damaging the product. Of these, rubber is the only one which can be extruded through a pressure releasing valve. The others require that the pressure drop be nearly simultaneous throughout the batch to avoid mechanical damage.

Figures have not been secured as to the relative commercial significance of the various applications and owing to the experimental nature of much of the work, it is entirely possible that the picture might change in the next decade. For example, installation of explosion pulverizers in a half dozen central power stations would involve a formidable tonnage of coal, perhaps enough to overshadow the importance of puffed cereals and masonite wood which are probably the most important uses today.

Bibliography

1. G. J. Bancroft. U. S. Patent No. 1,383,370.
2. Wm. H. Mason. U. S. Patent No. 1,578,609.
3. Wm. H. Mason. U. S. Patent No. 1,586,159.
4. Wm. H. Mason. U. S. Patent No. 1,824,221.
5. Wm. H. Mason. U. S. Patent No. 1,022,313.
6. R. M. Boehm, Masonite Corp. Private communication.
7. R. S. Dean and John Gross, Metallurgical Division. U. S. Bureau of Mines. Cf. Bull. No. 402, *Crushing and Grinding*, by Gross, Dept. of Interior (1938).
8. R. S. Dean, private communication.
9. Designed by C. Moss, Engineer, Bureau of Mines.
10. Cost Basis: steam=.013¢/lb.; electricity=1.5¢/kwh. Courtesy of R. S. Dean, private communication.
11. Cf. John Gross, *Crushing and Grinding*, pp. 67–79.
12. Studied by F. W. Godwin, assisted by the author, under the sponsorship of the Peabody Coal Company.
13. A. P. Anderson, U. S. Patent No. 707,892, 766,212 (1904).
14. *Ibid*, U. S. Patents No. 1,035,829–842, Inc.
15. *Ibid*, U. S. Patent No. 1,035,837.
17. Russell R. Gross, assignor to Xylos Rubber Co. U. S. Patent No. 1,963,943.
18. H. F. Palmer, Chief Chemist, Xylos Rubber Co., Akron, O.
19. H. F. Palmer, private communication.
20. A. P. Anderson, U. S. Pateent No. 990,093.
21. Roy Bainer and C. E. Barbee, "An Internal Combustion Nut Cracker", *Agricultural Engineering*, Jan. 1939.



Reaction kettles used for preparation of arylalkyl ketones. The most satisfactory method of preparation is by reacting fatty acid chloride with respective aromatic in presence of catalysts

New Fatty Acid Derivatives

A. W. RALSTON, *Armour & Co., Chicago, Ill.*

Chem. & Met. INTERPRETATION

Realization that fatty acids offer a starting point for the syntheses of many useful industrial chemicals is of comparatively recent date. This article appraises the present influence which fatty acid derivatives have had upon present-day industry and ventures some predictions as to their future possibilities and influence. —*Editors.*

Scientific developments in the oil and fat industry can be rather generally divided into two groups; and although there has been some overlapping, the two can be rather definitely distinguished. The first of these endeavors has looked toward an improvement in the glycerides themselves without a substantial loss or modification of the original glyceride structure and represents an attempt to make the glycerides more suitable to specific needs. This has resulted in improvements in the refining of both edible and inedible oils. Paint oils have been treated to remove their non-drying constituents. Hydrogenation has developed a series of edible fats which possess certain distinctive properties not present in the natural fats. The blending of various fats has developed mixtures which more nearly satisfy the requirements of both the edible and the inedible field. A ceaseless search is maintained for substances which prevent or retard rancidity and for refining and storage methods which give fats possessing better keeping qualities.

The second line of endeavor concerns itself with the use of fatty acids as a starting material for the production of a series of aliphatic compounds heretofore either unknown or commercially unavailable. This work has resulted in the production of fatty alcohols, amides, ketones, amines and many other derivatives which were, until a comparatively recent date, of academic interest only. Many resinous materials, synthetic varnishes, wetting and emulsifying agents, insecticides and other materials have been prepared from fatty acids, and the interest in such derivatives is rapidly increasing. This latter approach to the problems of the fat industry has and will continue to exert a profound effect, not only upon the fat industry itself, but upon industry in general. This article is an attempt to appraise the present influence which fatty acid derivatives have had upon present day industry and to venture some predictions as to their future possibilities and influence.

Before discussing the compounds which have been prepared from fatty acids, a brief review of what fatty acids are and how they are obtained from fats is necessary. The fatty acids consist essentially of straight chain monocarboxylic acids of the general formula RCOOH. The R group may be saturated, as in the case of lauric, $C_{11}H_{23}COOH$; myristic, $C_{13}H_{27}COOH$; palmitic, $C_{15}H_{31}COOH$; or stearic acid, $C_{17}H_{35}COOH$; or it may contain one or more olefinic bonds as in oleic acid, $C_{17}H_{33}COOH$; linoleic acid, $C_{17}H_{31}COOH$; or linolenic acid, $C_{17}H_{29}COOH$. The fats of various plants and animals contain characteristic amounts of various fatty acids. Fish oils, for example, contain large amounts of highly unsaturated acids; coconut oil is high in lauric acid and the short chain, saturated acids, tung oil contains eleostearic acid and castor oil is characterized by ricinoleic acid. Oleic acid is the most frequently occurring of all fatty acids, and palmitic acid is the most abundant of the saturated acids.

In order for the fatty acids to be useful as a starting point for synthetic work, it is necessary to separate them, either into individual acids or mixtures of acids having common properties. Since, as has been previously pointed out, most of the naturally occurring fats or oils consist of mixed glycerides, it is impossible except in rare cases to obtain pure fatty acids by working through the glycerides. The general principle employed for obtaining the acids from their glycerides is to split the esters either by hydrolysis with steam in the presence of catalytic agents or to saponify the fats in which case a soap and glycerine are obtained. Fatty-acid mixtures are then obtained from these soaps by acidification. A large commercial source of fatty acids is the residue or "foots" which result from the process of alkali refining of vege-

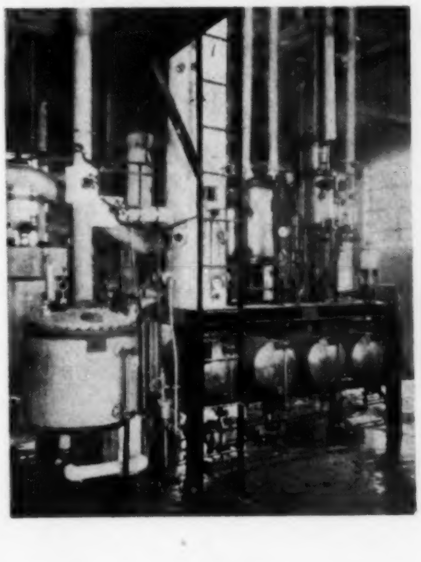
table or animal fats. These foots consist of a mixture of soaps, free acids, glycerides and non-saponifiable matter and the acids are obtained from them by acidification.

Fatty acid mixtures prepared by any of these procedures are separated into either essentially pure acids or into mixtures of acids having similar properties. The purpose of this separation is twofold; first, to remove unsaponifiable matter, polymerized acids, hydrocarbons, etc., from the acids; and, second, to separate the acids themselves into commercially desirable fractions. The particular means employed for this separation depends to a considerable extent upon the type of acid mixture to be separated and the purpose of the separation. Graining and pressing are often used for the separation of the saturated acids of high molecular weight such as palmitic and stearic acids from unsaturated acids such as oleic and linoleic acids. This process depends upon the difference in melting points and mutual insolubilities and can be effectively employed where the acid mixtures are of relatively simple composition, such as the acid mixture obtained from beef tallow. A number of modifications of this method have been proposed, some of which are employed commercially. Novel methods of cooling or the addition of components which modify the rate of crystallization or change the solubilities have often been used. Solvent extraction, which depends upon the preferential solubility of one or several of the component acids, has been proposed. By far the most effective means of separation now known is fractional distillation of the acid mixtures. This process is conducted at reduced pressures in specially designed stills constructed of acid-resistant alloys.

The fatty acids obtained by any of the above processes serve as starting materials for the syntheses of many interesting derivatives. It is, for example, now possible to prepare mixtures of unsaturated fatty acids essentially free from saturated acids and such mixtures are finding an increasing use in the paint and resin industry. By the removal of the saturated, non-drying acids from fish oil acids, soy bean oil acids and acids of other semi-drying oils and the re-esterification of the unsaturated fraction with glycerol, synthetic glycerides can be prepared which compete with the natural drying oils. Such acid mixtures are also extensively employed in the plastic industry for modifying glyptals and other resins. Synthetic drying oils can be prepared by the condensation of unsaturated acids with unsaturated hydrocarbons; phenol-formaldehyde resins have been modified by the inclusion of acylated phenols. An appreciable amount of research is now in progress upon the development of synthetic products derived from the fatty acids which will possess better drying properties than the naturally occurring drying oils. It is possible that in the not far distant future the natural drying oils will be largely replaced by synthetic products free from many of the defects inherent in the natural oils.

Research upon fatty acid derivatives has resulted in the preparation and commercial production of many compounds which were previously unknown or which existed only as academic curiosities. It is impossible to discuss many of these developments in detail, but it is desirable to leave with the reader some insight into this field and its possible significance. Realization that the fatty acids offer a starting point for the syntheses of many useful industrial chemicals is of comparatively recent date. Aromatic compounds derived from coal tar have entered all fields of chemical endeavor as a result of research and development, whereas aliphatic chemistry and aliphatic compounds have never received the consideration which they justly merit. Most of the general synthetic reactions now applied to the coal tar derivatives can be applied to aliphatic materials and the realization of this fact has served to stimulate interest in this field. The number of dyestuffs, pharmaceuticals, insecticides, etc., can be greatly increased by the introduction of aliphatic groups. Most of the compounds derived from the fatty acids are characterized by the presence of the long chain alkyl group, and many of their properties are dependent upon the presence of one or more of these groups.

Stills like the one here illustrated are used for the experimental fractionation of fatty acid derivatives



The preparation and properties of a few of the more important fatty acid derivatives follows:

Alcohols—The fatty alcohols are prepared by the catalytic hydrogenation of either the fatty acids or their glycerides. The general reaction for this preparation is as follows:

$$RCOOH + 2H_2 \rightarrow RCH_2CH + H_2O$$

They can also be prepared by the deaminization of amines by the following reaction:

$$RCH_2NH_2 + HNO_2 \rightarrow RCH_2OH + H_2O + N_2$$

The higher fatty alcohols are oily liquids or waxy solids. Octyl alcohol, $C_8H_{17}OH$ melts at -16.3 deg., decyl alcohol, $C_{10}H_{21}OH$ at 7 deg. and dodecyl alcohol, $C_{12}H_{25}OH$ at 22.6 deg. The higher members are solid at ordinary temperatures. These alcohols become increasingly less soluble in water with increasing molecular weight. They show the characteristic reactions of the low molecular weight alcohols, such as ester formation with mineral acids, etc. Commercially, they are quite often employed as the sodium salt of the sulphuric acid ester. Sodium lauryl sulphate, for example, has been extensively used as a detergent, wetting agent, emulsifying agent and as a chemical intermediate for the preparation of various derivatives. Detergents prepared from these higher alcohols are stable in hard water and their use is indicated in many textile processes. The commercial value of these fatty alcohols and their derivatives is largely dependent upon the physicochemical properties of their solutions. They have recently been proposed as insecticides.

Various synthetic waxes, which approach natural waxes in composition and physical properties, can be prepared by esterifying these higher alcohols with fatty acids. Compounds such as hexadecyl palmitate, prepared by the esterification of hexadecyl alcohol by palmitic acid, or montanyl montanate are representative of this type of compound.

Aldehydes—Fatty aldehydes can be considered as an intermediate between fatty acids and higher alcohols. A number of methods have been proposed for their preparation, one of the simplest of which is to heat the calcium salt of the fatty acid with calcium formate. This method is satisfactory for the lower members of the series but gives poor yields with the higher members. One very satisfactory method for the preparation of the higher aldehydes is to pass the acids along with formic acid over a catalyst at elevated temperatures.

The high molecular weight aldehydes are oily liquids or wax-like solids. They are used in the perfume industry, and have a large potential use in the resin industry if they can be prepared at nominal costs.

Ketones—Ketones have the general formula R(CO)R. Two general types of ketones can be prepared from the fatty acids. One of these types is the dialkyl ketones in which both the R groups are aliphatic radicals derived from the fatty acids. Stearone, $C_{17}H_{35}.C\ C_{17}H_{35}$; myristone $C_{13}H_{27}(CO)C_{13}H_{27}$; and laurone $C_{11}H_{23}(CO)C_{11}H_{23}$ are examples of aliphatic ketones in which both R groups are similar or derived from the same fatty acid. Methylheptadecyl ketone, $CH_3(CO)C_{17}H_{35}$ and undecylheptadecyl ketone, $C_{11}H_{23}$-$(CO)C_{17}H_{35}$, are examples of aliphatic ketones in which the R groups are derived from different acids.

These dialkyl ketones can be prepared by pyrolysis of the calcium soaps of the acids or by passing the vapors of the respective acids over catalysts at elevated temperatures. For example, lauric acid yields laurone; a mixture of capric acid and stearic acid will form caprone, stearone and nonylheptadecyl ketone.

The second type of ketones which can be prepared from fatty acids are the arylalkyl ketones in which one of the R groups is an aliphatic, the other an aromatic radical. Examples of such ketones are: stearophenone (phenylheptadecyl ketone), $C_{17}H_{35}(CO)C_6H_5$; laurophenone, C_{11}-$H_{23}(CO)C_6H_5$ and diphenylheptadecyl ketone $C_{17}H_{35}(CO)C_6H_4C_6H_5$. The arylalkyl ketones cannot be prepared in commercial yields directly from the acids. The most satisfactory method for their preparation is by reacting the fatty acid chloride with the respective aromatic in the presence of catalysts such as aluminum chloride.

In general the ketones prepared from fatty acids are wax-like solids, which show most of the reactions characteristic of ketones. Reduction gives secondary alcohols which can be sulphonated to products having detergent properties. The ketones are useful as wax substitutes in polishing and cleaning compositions, as dielectric materials, as plasticizing agents, as water-proofing agents for paper or textiles and as chemical intermediates for producing numerous products.

The arylalkyl ketones present one of the most important types of derivatives which have been prepared from fatty acids. They are useful as wax substitutes, mineral oil addends, plasticizing agents and as resin components. Ketones prepared from phenol and high molecular weight acid chlorides can be used to replace a portion of the phenol used in a phenol-formaldehyde resin, while those prepared from indene, coumarone, styrene or the cyclodienes can be copolymerized with more of the parent hydrocarbon for the production of a large number of resins.

Acid Chlorides—Fatty acid chlorides are prepared directly from the fatty acids by the replacement of the carboxyl group, —COOH, by the group, —COCl. This is accomplished by the action of thionyl chloride, phosphorus trichloride or phosphorus pentachloride upon the respective acids. The high molecular weight acid chlorides are high-boiling liquids which are easily hydrolyzed to fatty acids and hydrochloric acid by moisture. They are one of the most important of the fatty acid derivatives because of their chemical reactivity. Since they are unstable in the presence of moisture, no important chemical use other than as a chemical intermediate has been developed for them. They are used in the preparation of esters, in acylations and in any reaction where it is desirable to introduce an acyl group. Reactions with alcohols, such as ethyl alcohol, result in the corresponding alkyl esters; reactions with phenols give the phenyl esters. They have been frequently used for the esterification of high molecular weight organic materials such as starches, cellulose, etc. Examples of these esters are cellulose laurate, cellulose stearate, etc., which are used in synthetic fibers, photographic films, plastics, lacquers and water-proofing materials. It has been proposed to treat fibers directly with these acid chlorides in order to impart water resistance to them. Substances such as dyes, polymerized hydrocarbons, gums, rosin, and so forth, may be treated with these acid chlorides to give a large number of interesting and valuable products.

Esters—The simple alkyl esters such as amyl stearate or ethyl oleate can be prepared by alcoholysis of glycerides with the respective alcohols, or by direct esterification of the fatty acids. Esters of polyhydric alcohols can be prepared by the action of an acid chloride upon the alcohol or by the action of soaps with glycerine or a chlorohydrin. Aromatic esters such as phenyl stearate are generally prepared by the action of an acid chloride upon a hydroxy aromatic compound.

The alkyl esters are generally high-boiling liquids which are used as plasticizers, lubricating oil addends, water-proofing agents, etc. Esters of polyhydric alcohols, examples of which are the so-called mono- or di-glycerides, are used as emulsifying agents particularly for the preparation of edible emulsions. They are frequently encountered as the sulphuric or phosphoric acid esters which have a rather wide application because of their emulsifying and wetting properties.

Amides—When ammonia is passed into a fatty acid, an ammonium soap is first formed which, upon further heating either in the presence or absence of a catalyst, loses a molecule of water and is converted into an amide according to the following equation:

$$RCOONH_4 \rightarrow RCONH_2 + H_2O$$

These amides are crystalline bodies which melt around 100 deg. C. Stearamide, $C_{17}H_{35}CONH_2$ melts at 108.5–109 deg. C. and lauramide, $C_{11}H_{23}CONH_2$, melts at 110 deg. C. Mixtures of these amides are wax-like solids with melting points somewhat below those of the pure compounds. These amides are insoluble in water, soluble in hot alcohol or ether, very soluble in hot benzine or toluene. They are relatively inert chemically and can only be hydrolyzed to the corresponding acids by the application of caustic solutions under pressure or by strong acids.

Amides are useful as finishing waxes, water-proofing agents and as chemical intermediates. Many of

their derivatives are excellent emulsifying agents and detergents.

Nitriles—When the amides are heated to high temperatures, they are converted into nitriles according to the equation:

$$2RCONH_2 \rightarrow RCN + RCOOH + NH_3$$

If this reaction takes place in the presence of excess ammonia, the acids will be reconverted to amides and the cycle repeated until a quantitative conversion into nitriles is obtained.

The aliphatic nitriles containing from 6 to 16 carbon atoms are liquids, and those above 16 carbon atoms are low melting solids. The lower molecular weight nitriles, from C_6 to C_{10} have characteristic odors; those above C_{10} are essentially odorless. Nitriles are commercially interesting as intermediates for the preparation of amines. Lauronitrile, $C_{11}H_{23}CN$, is an excellent insect repellent and is much more effective for this purpose than substances now generally used, such as oil of citronella. Nitriles have been suggested as flotation agents for the separation of metallic ores. High molecular weight nitriles are not toxic to animals or humans, and large amounts may be consumed by animals without apparent discomfort.

Nitriles are stable in the presence of dilute acids or alkalies. They are hydrolyzed to the corresponding amides by the action of concentrated sulphuric acid.

Aliphatic nitriles can be cracked by processes similar to those employed in the petroleum industry for the cracking of hydrocarbons. Lower chain saturated and unsaturated nitriles and saturated and unsaturated hydrocarbons are formed by this process. The cracked nitriles are useful for the preparation of a number of lower chain fatty acid derivatives. Separation of the nitriles and hydrocarbons has been effected by several methods.

Amines—The high molecular weight aliphatic amines are the most interesting and commercially important nitrogen-containing derivatives of the fatty acids. The amines can be considered as substituted ammonias and are classed as primary amines, RNH_2; secondary amines, R_2NH, and tertiary amines, R_3N, depending upon whether one, two or three alkyl groups are attached to the nitrogen atom. The primary and secondary amines can be prepared by the catalytic hydrogenation of the corresponding nitriles, and the hydrogenation will result either in high yields of primary or high yields of secondary amines, depending upon the hydrogenating conditions employed.

Aliphatic amines may also be prepared by the action of ammonia upon alcohols according to the following general equation:

$$ROH + NH_3 \rightarrow RNH_2 + H_2O$$

The primary amines containing less than 12 carbon atoms are liquids; those above 12 carbon atoms are low-melting solids.

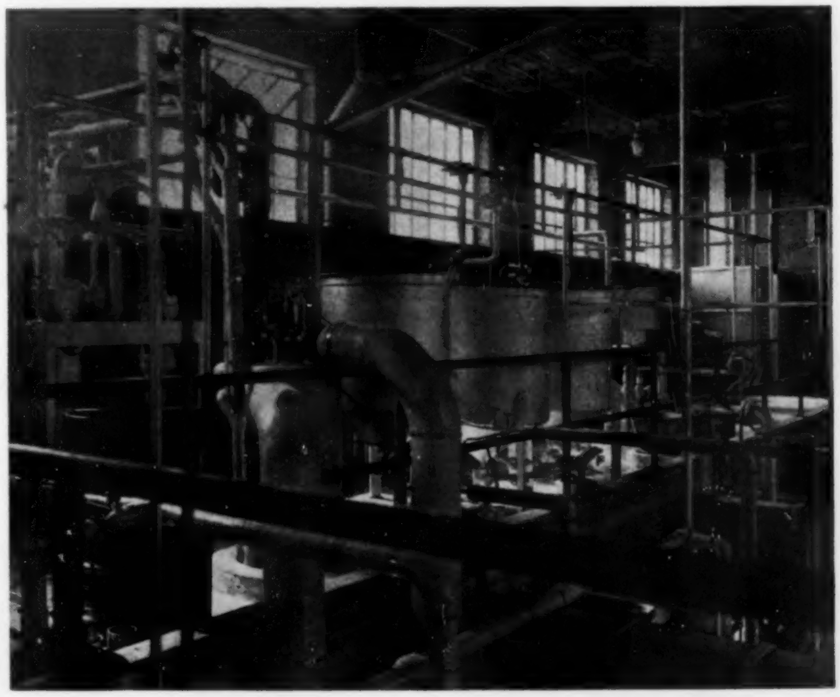
The secondary amines have much higher boiling points than the corresponding primary amines. The primary amines are quite soluble in alcohol, the secondary amines are much less soluble. The solubility of the primary amines in water decreases rapidly with increase in the chain length; water, on the other hand, is appreciably soluble in the amines although the solubility becomes less with increase in the molecular weight of the amine. The secondary amines are less soluble in water than the primary amines and the tertiary amines are still less soluble.

With organic and mineral acids the amines form salts most of which, with the exception of the carbonates or sulphates, are appreciably soluble in water. These amine salts are all crystalline solids, a number of which decompose before melting.

The amines and their derivatives are effective wetting agents. The quaternary ammonium salts are the so-called "cationic" reagents which are extensively used as wetting agents, dye assistants, etc. Amine salts are strongly adsorbed by many minerals, particularly the silicates, and have been employed for the froth flotation separation of siliceous ores. Both the free amines and their salts impart plasticity to clays, limes and finishing plasters. They are useful in water treatment, as antifoaming agents, in textile-finishing, as flocculating agents for turbid waters, as dispersing agents, as bactericides, as sterilizing agents and in many other fields. Dioctylamine is an excellent insecticide and appears to be a substitute for pyrethrum. The amines are useful as starting materials for the preparation of oil-soluble dyes, detergents and surface-active compounds in general.

In this discussion of the fatty acid derivatives, it must be realized that only the major types of derivatives have been discussed. Each of these types serves as a basis for the preparation of numerous compounds which have specific properties and specialized uses. It is believed that the fatty acid derivatives will contribute materially to the solution of many industrial problems as our knowledge of these derivatives increases.

Portion of a pilot plant for the preparation of fatty acid derivatives. Research upon fatty acid derivatives has resulted in the preparation and commercial production of many compounds which were previously unknown



Chemical Industries: 1899-1937

SOLOMON FABRICANT

National Bureau of Economic Research, Inc., New York, N. Y.

Chem. & Met. INTERPRETATION

As plans were being made for *Chem & Met's* Facts and Figures III, the National Bureau of Economic Research published Dr. Fabricant's book, "The Output of Manufacturing Industries, 1899-1937." This brief article is a condensation of the book's sections which discuss growth and changes in American chemical industries.—*Editors.*

During the period from 1899 to 1937, manufacturing output of this country increased by 276 percent. This means that—through the comparatively quiet years 1899 to 1914, the war upheaval from 1914 to 1919, the rapid expansion of the 1920's and the troubled years following 1929—manufacturers have increased their physical output at an average rate of 3.5 percent a year.

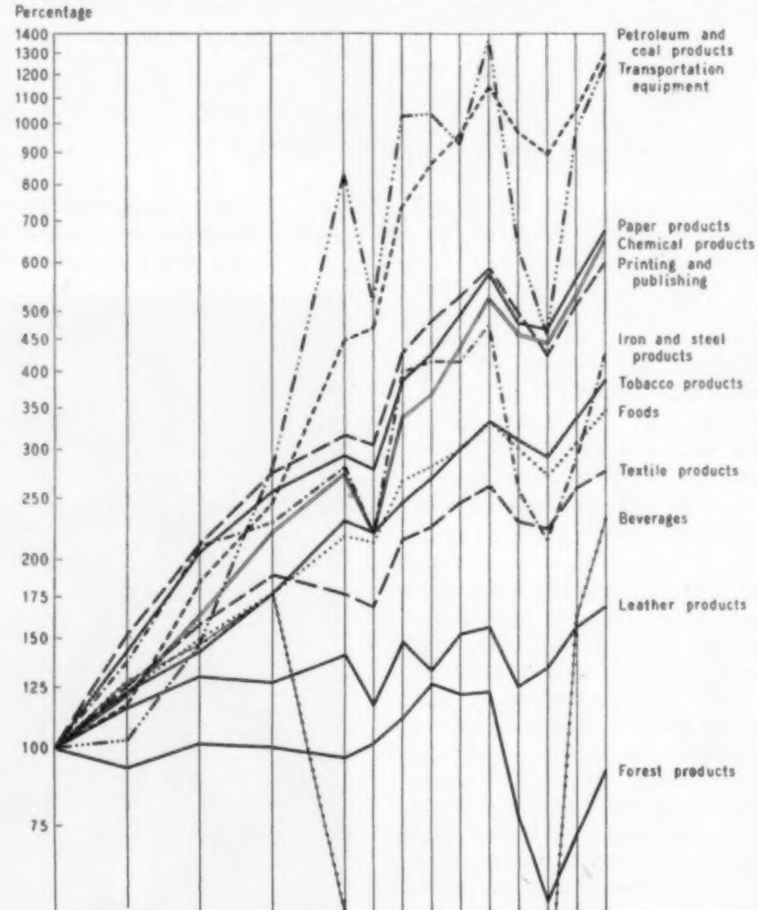
In this period, factory output changed not only in volume but also in composition. Between the two years, the forest products group ceased to be the largest contributor to the nation's manufactured goods. Textiles also declined in relative importance. But chemical products increased their share of the aggregate, as did transportation equipment and printing and publishing enterprises. In absolute terms, there were very large increases, in the physical output of transportation equipment, petroleum and coal products, chemical products, paper products and products of the printing and publishing industries. The physical output of each of the first two groups was more than 12 times as large in 1937 as it had been in 1899. Chemical products, paper products, and printing and publishing grew six- or sevenfold during the 38 years. In contrast, the physical output of the forest products group actually declined by seven percent, while leather products rose only 69 percent, less rapidly than the population, which increased by 73 percent.

Despite the gain in aggregate output of the chemicals group, which far exceeded the rise in total manufacturing, most of the industries in the group failed to grow as rapidly as that total. However, these industries, which include cottonseed products, fertilizers, explosives, wood distillation products, and salt, among others, are the less important members of the group, measured in terms of value added. The large Census industries "Chemicals, not elsewhere classified" and paints and varnishes, gained 700 and 400 percent respectively. Although rayon did not come into use until around 1909, it soon became one of the larger industries of the group, and by 1937 its output was 150 times that of 1914. Compressed and liquefied gases and carbon black (an important material in rubber manufacture), also made very substantial gains. The pattern of production for the entire chemicals group clearly reflects the great diversion of trends. "Chemicals, not elsewhere classified," rayon and gases contributed only 10 percent to the group's output in 1899, and as much as 42 percent in 1937.

Chemicals, not elsewhere classified, the most important industry in the group, consists of establishments producing acids, nitrogen compounds, sodium and potassium compounds, aluminum compounds and alum, coal tar products and plastics. Prior to 1923, this classification included also rayon manufacture, and prior to 1927, compressed and liquefied gases. The growth of the industry has been phenomenal. Between 1899 and 1937, chemicals, n.e.c., (including the two branches separated out in 1923 and 1927), increased production by 2,500 percent.

Especially outstanding were the rises in the output of phosphoric acid, sulphuric acid, anhydrous am-

Starting from a common point (1899-100), indexes for major groups of manufacturing industries show substantial differences in output trends



monia, borax, sodium silicate, coal tar dyes, butyl acetate, carbon bisulphide, ethyl ether and ethyl acetate. Among the products which appear to have been constant or declining in output for some length of time, are oleic acid, sodium bicarbonate, sodium sulphate, cream of tartar, aluminous abrasives, pyroxylin plastics, and refined sulphur.

Rayon and compressed gases, the two branches of the industry which were treated separately in the Censuses of 1923 and 1927, respectively, grew more rapidly than the other branches of chemicals, n.e.c. In terms of volume, rayon production increased from 2.4 million lb. in 1914 to 321.7 million in 1937.

Compressed and liquefied gases also increased at a phenomenal rate. Output in 1937 was 42 times greater than it had been in 1909.

The output of cottonseed oil, cake and meal rose by less than two-thirds from 1899 to 1937. The peak in the series came in 1914, but 1927 output was only 10 percent lower. Two by-products of the industry, cotton linters, and cottonseed cake and meal increased more rapidly than the output of cottonseed oil; and a third, cottonseed hulls, changed but slightly.

The soap industry is one of the most important in the entire chemicals group in terms of value added. The output of the industry moved upward at a comparatively slow rate: from 1904 to 1937 the increase was 140 percent.

A very important industry, paints and varnishes, increased its output almost five times in the years 1899–1937.

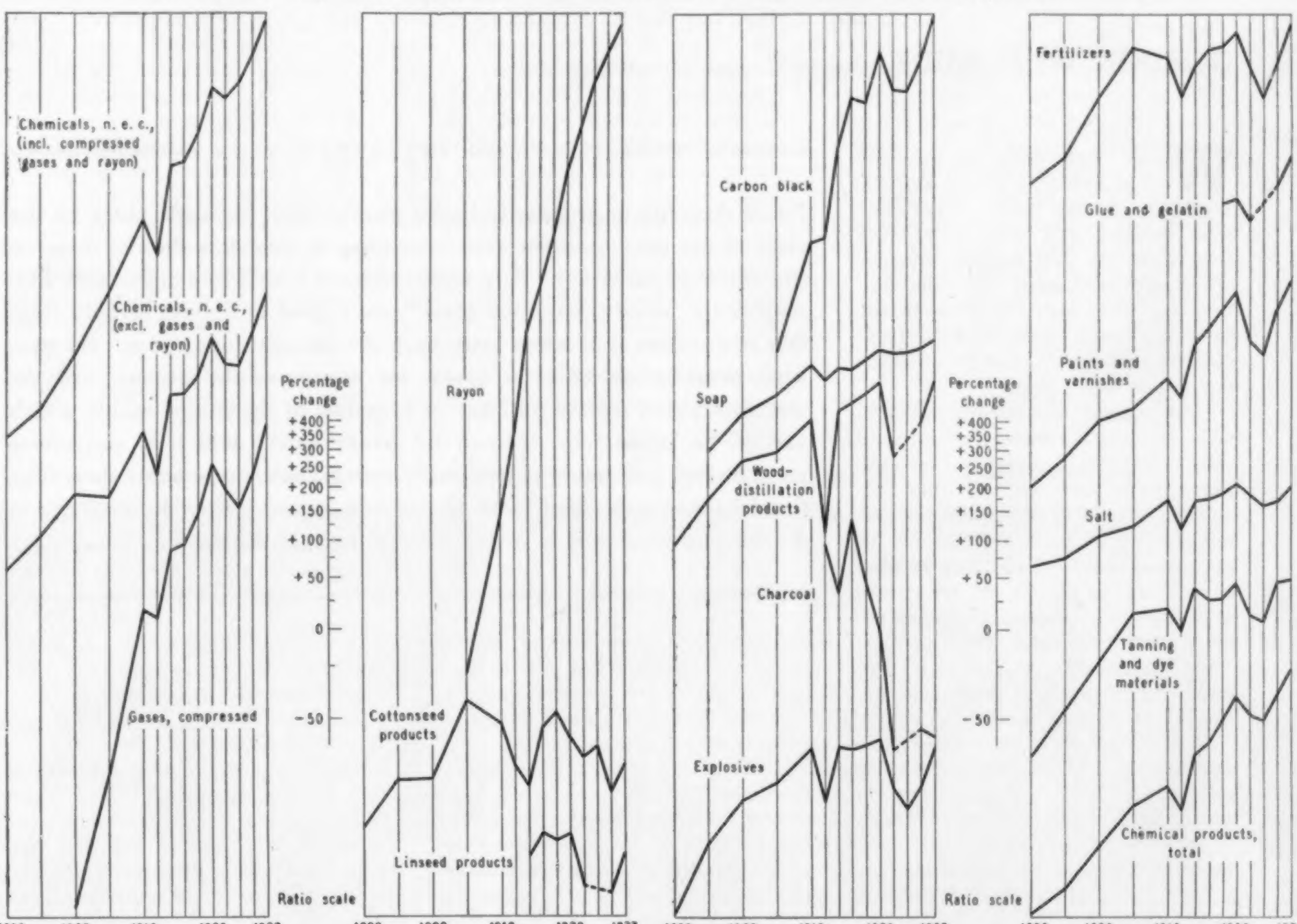
Salt, a laggard industry in the chemicals group, increased in output only 82 percent in the 38 years between 1899 and 1937.

Other industries which have increased outputs during the 38-year period for which the Census makes data available are carbon black, charcoal from wood distillation (259 percent), explosives (267 percent), fertilizers (250 percent), and tanning and dyeing materials (almost fourfold). Industries which have been declining are bone black and lamp black (since 1914), and linseed products (since 1929).

In only one period, 1929–37, did more than one chemical industry decline in output. Even in that period, however, ten out of the fifteen industries for which we have data increased their output. Over the long period, 1899–1937, all but one of the chemical industries reported increases in output more rapid than the growth in population.

Census data on value added (value of products less cost of materials, fuel, etc.), when expressed in terms of relative contribution of component industries to the value added to the entire group, indicate changes in relative standing of industries for which no data on physical output are available. Outstanding declines are noted in drugs and patent medicines which fell from 26.8 percent in 1899 to 16.1 in 1937. The contribution of toilet preparations rose from 2.0 percent in 1899 to 7.8 in 1929, then dropped to 4.4 in 1937. Ammunition reached a peak in 1919 and declined in the ten years following.

Of the 30 industries included in the chemical group, there are adequate quantity statistics for 15. For only eight, however, do the indexes extend over the entire period 1899-1937



The Allegheny River flooding one of Pittsburgh's manufacturing districts

Planning Flood Precautions To Minimize Plant Losses

GORDON W. McBRIDE, *Chemical Engineer, Washington, D. C.*

Chem. & Met. INTERPRETATION

Flood damage to process industry plants often depends more on the skill of the management exercised long in advance than it does on the depth of the water. Any establishment which has organized thoroughly its "flood prevention crew" can expect to benefit largely from this precaution if at some later time the deluge does come. No general prescription can be given for every establishment; but the accompanying article outlines or suggests of the major points which should be taken into account by every works which is anywhere near a river that might conceivably reach flood stage some day. The flood season runs from now til the late spring. Now is the time to do the planning and to organize and instruct the staff.—*Editors.*

WHEN THE RIVER is at flood stage and still rising and the Weather Bureau says "continued rain tonight and tomorrow," it's time to refresh your memory on some of Noah's techniques. For the convenience of plant management the following pages present a modernized conception of what to do when the waters are rising.

Development will be attempted in more or less chronological form in three sections, covering advance preparation, crest activity, and "renormalization." The various actions indicated should be considered in approximately the order presented as far as timeliness is concerned. However, conditions at an individual plant will determine which actions are unnecessary, or perhaps less important than some subsequent action which must be taken.

If your plant is in a flood zone like the Ohio or Mississippi Valleys, talk with the U. S. Weather Bureau men. They have had considerable experience in predicting the crest height of floods. Where a matter of a few inches may make a difference, this forecasting can be speeded up by intimate acquaintance at the Weather Bureau. For example, a man from your plant might be stationed at the Weather Bureau to phone each calculation as it is made. By this means radio and newspaper forecasts may be anticipated by a matter of hours. These official forecasts may need to be supplemented by hourly reports from company observers stationed a few miles upstream from the plant. The effect of local rainfall must be considered in addition to the regional fall. Sudden rise of a small tributary may be just as damaging as the slow rise of the main stream.

The plan which is outlined here is for defense against a slow rising flood, for which preparations may be made over several days. If the plant is located on a small stream, or on a narrow flood plain, preparations may have to be made in a mat-

ter of hours. A condensed plan should be drawn up for such individual plant, based on this broad comprehensive outline, but so based that it can be executed on short notice with a minimum of delay. For such short plan, the factors of safety, money value, replacement time, order of submersion, and so forth must be balanced. As many of the items as time permits can then be done in order of relative importance.

ADVANCE PREPARATION

Building protection is, of course, the first thought. Sandbags in doorways and low windows will effectively take care of a few feet of water. Pumps and steam siphons should be rigged up for handling seepage. Sewers should be supplied with flood gates to prevent backing up of water through lines of normal drainage. If the plant is located on porous ground much trouble may be experienced from seepage.

Perishable equipment should be moved as an elementary precaution. Such electrical items as motors, starting boxes, recording and indicating instruments, and storage batteries come to mind. In case of large pieces of equipment like engines and machine tools, liberal coatings of grease should be quickly applied to prevent water damagee.

Furnaces should be cooled, in anticipation of flooding. Vents should be extended on underground fuel tanks. Since many floods occur in winter time, coils and closed equipment should be drained and pipes opened to eliminate danger of freezing. All manufacturing processes should be brought to as orderly a stop as possible to avoid injury to the product.

Tanks which are in the flood zone require careful treatment. If they are empty either of two procedures is recommended: They may be filled with water to the level of an open manhead, or the bottom may be opened so the rising flood water will fill them automatically. If the latter course is chosen, care must be taken to open the tanks at the very bottom or not more than an inch or two above the bottom. An empty tank will float in a few inches of water and, once afloat, considerable work may be necessary to guide the tank back to its proper foundation.

Tanks which are partially filled may, if time permits, be held down by pumping in more of their normal contents, or water may be pumped in if the tank contents are not seriously damaged by such action. The separation problem can be dealt with after the flood has receded. If it is not possible to pump more liquid into tanks, the piping may be disconnected and the tank allowed to float as the flood waters rise. Anchor lines should then be used, but only with constant supervision.

Electric power, low pressure steam, and fire protection should be maintained at all costs. Sandbags, coffer dams, siphons, steam driven boiler feed pumps (which will operate under water, by the way), and oil lantern illumination are some of the accessories that are most useful.

Raw materials in storage must be considered from a number of angles. The replacement time of any given raw material must be weighed against its actual money value. Occasionally a low unit cost material may not be quickly replaceable, resulting in greater over all loss if a long holdup in production were necessary.

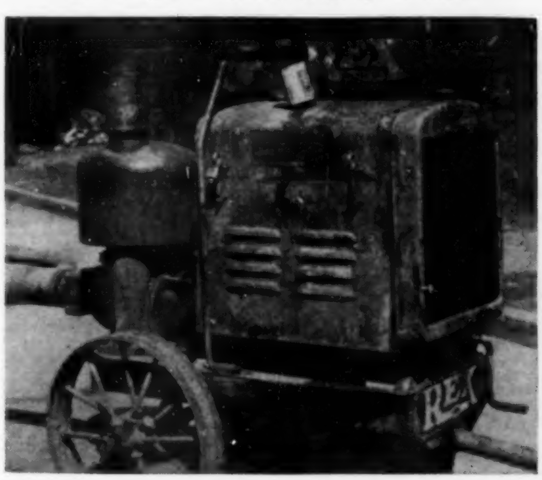
Finished products in the warehouse should be moved from basements first, of course. They should be shipped if possible, or stored on higher ground if readily available. If storage within the plant is necessary, warehouse conveyors may be reversed and products stored on the upper floors of the manufacturing buildings. Here again the replacement time must be considered. Product demand and good will must be weighed against money value. If time and conditions permit the warehouse should be protected like the power plant.

The contact of certain chemicals with water causes hazards which need special precaution. For example, calcium carbide or metallic sodium are serious fire hazards. If water gets into a storage tank of concentrated sulphuric acid, not only the acid is lost by dilution, but the tank may also be lost in short order through attack by the diluted acid. Another difficulty to guard against is the damage to buildings and equipment by corrosive chemicals which may leak or spill into flood water. If a storage tank of concentrated nitric acid should be floated off its foundation and spill some of its contents onto a combustible material, a fire might quickly result.

Any such chemicals may raise problems comparable with the fire hazard of flood borne gasoline or oil. Competent employees should be instructed in the proper precautions to take with each material in case of flood, and should be given the primary responsibility for this particular job when occasion arises.

Office equipment on the lower floors of threatened buildings demand urgent consideration. Records, files, and safe contents should be moved at the very first. Such equipment as typewriters, calculat-

Gas engines meet emergency in flood



Debris in a plant after a recent flood that caused great damage

ing machines, and other portable office machinery should be kept out of water. If time and space permit, furniture should be moved to upper floors, or it may be stacked on the water-filled drums. The telephone switchboard should be raised in a similar manner. Needless to say, temporary quarters for the office staff should be found.

Emergency reorganization of the personnel should be on a 24-hour basis. Flood-fighting and clean-up supplies should be procured as quickly as possible, preferably in advance of the flood. Such items as rubber boots, brooms, squeegees, flashlights and batteries, lanterns, fire extinguishers, boats, and life preservers are essential. The plant carpenter shop can helpfully supplement the available supply of boats with crude barges and rafts, using high ground for the "ship yards."

CREST ACTIVITIES

Crest activities may be a matter of a week's routine, as in the case of the Ohio River flood of 1937, or they may be of negligible duration. Plant protection is vital, of course, however long the crest lasts. Special watchmen should be detailed to each flooded building. Strict fire regulations must be imposed. A temporary "fire boat" may be invaluable. The equipment can be transferred later to a truck if normal fire protection is not immediately restored. Low pressure steam should be maintained to protect the plant against freezing.

If possible, shipments should be maintained to fill orders. Stock should be taken from temporary storage locations first, of course. Extra inspection is advisable for the special handling necessary in such a time.

Plans for clean-up and salvage should be laid out during the crest period. Electricity, gas, water, and fire protection should be restored as soon as possible, of course, to various departments of the plant in order of urgency. Mechanical and electrical repairs must be anticipated. Sanitation and health precautions must always be maintained. Building and equipment cleanup and repainting will be necessary and damaged products must be reclaimed. Extra inspection on the finished product should be planned for the start-up of the plant.

During the flood crest, food and first-aid must be available on a 24-hour basis. Coffee, soup, and hot stew are the stand-bys of the food department. Drinking water may have to be imported. Typhoid innoculation or pills and boiling of all drinking water are strongly recommended. Emphasis should be placed on the importance of thorough washing before eating, also. Washing with soap and water, followed by a chlorinated water rinse, has been found effective in preventing outbreak of flood-borne diseases.

"RENORMALIZATION"

In some cases, production may be resumed while water is still in the buildings. Ferry service to the upper floors may be necessary, with temporary power house on a raft for the most urgent start-up. Within the limits of the Fair Labor Standards Act, overtime operation could be scheduled for employees to earn any loss occasioned by the shut-down.

Flood experience has shown that it requires about a week to restore a department to operable condition after the water actually leaves. Complete "renormalization" of the plant, however, may be a long-time problem even though the flood be short-lived. Streets, buildings, and sidewalks must be hosed and brushed. Inside walls of buildings must be washed with soap and water, preferably followed by a chlorinated water rinse. Painting can be done on a leisurely schedule after production is going smoothly.

Tanks should be guided onto their foundations as the water drops. If the flood recedes so fast that the tanks may not all be guided onto their foundations properly, they may be diked and re-floated to position later. Machinery must be cleaned and oiled. ("After the Flood" by G. A. Van Brunt. *Factory Management and Maintenance.* Vol. 93, p. 400-401 (1935).) Re-arrangement of machines while reconditioning should be considered at this opportune moment.

Electrical equipment must be cleaned and oven-dried. Conduits may be dried with hot air, or perhaps re-wired to advantage after swabbing. Electrical circuits must be tested for shorts. ("When Electrical Equipment Gets Wet" by E. C. Dieffenbach. *Factory Management and Maintenance.* Vol. 91, p. 186-188 (1933).) Drinking water supplies should be restored. The pipes should be flushed with chlorinated water and bacteriological analyses should be run on the drinking water before permitting use of the fountains by employees in order to prevent sickness.

Flood damaged office furniture can frequently be repaired in the plant carpenter shop. Soaked files and papers may be dried by a photographer's print-drying drum, or on domestic mangles. Although stained and wrinkled, legibility may still be good.

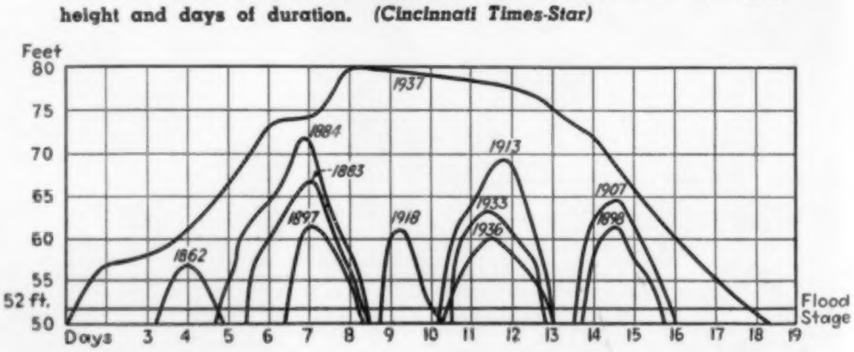
SALVAGE

Salvage of manufactured goods may stretch out over a considerable length of time, also. Damaged goods, segregated from the undamaged, should be reworked or degraded so that quality standards are maintained without sacrifice. An inventory of the loss, damage, and reclaim should be made.

Finally, an accounting may be made to see how much the flood cost. It will not be a pleasing figure! But if the flood precautions were well planned in advance, and executed promptly when necessary, the cost will be less than if only haphazard measures were taken after the flood began.

Gage Height and Duration of Cincinnati's Floods

The 1937 flood exceeded all previous Cincinnati floods in both gage height and days of duration. ***(Cincinnati Times-Star)***



Technical Societies and Trade Associations

AIR CONDITIONING & Refrigerating Machinery Assn. Inc. Exec. Vice-Pres., William B. Henderson, 717 Southern Bldg., Washington, D. C.

Aluminum Research Institute. (Secondary Aluminum Ingot) R. D. T. Hollowell, 308 West Washington St., Chicago, Ill.

Amer. Assn. for the Advancement of Science. Perm. Sec., F. R. Moulton, Smithsonian Inst. Bldg., Washington, D. C.

American Association of Cereal Chemists. Treas., Perle Rumold, Standard Milling Co., 18th & Kansas Ave., Packers Station, Kansas City, Kan.

Amer. Assn. of Engrs. Sec., M. E. McIver, 8 S. Michigan Blvd., Chicago, Ill.

Amer. Assn. of Textile Chemists & Colorists. Sec., Dr. H. C. Chapin, c/o Lowell Textile Institute, Lowell, Mass.

Amer. Bakers Assn. Pres., L. J. Schumaker; Sec., Tom Smith, 1135 Fullerton Ave., Chicago, Ill.

Amer. Bureau of Metal Statistics. Dir., W. R. Ingalls, 33 Rector St., New York.

Amer. Ceramic Society. Gen. Sec., Ross C. Purdy, 2525 N. High St., Columbus, Ohio.

Amer. Chemical Society. Sec., Dr. Charles L. Parsons, Mills Bldg., Washington, D. C.

Amer. Concrete Institute. Sec., Harvey Whipple, 408 New Center Bldg., Detroit, Mich.

Amer. Drug Mfrs.' Assn. Exec. Vice-Pres.-Sec., Carson P. Frailey, 506 Albee Bldg., Washington, D. C.

Amer. Electroplaters' Society. Exec. Sec., W. J. R. Kennedy, 93 Oak Grove Avenue, Springfield, Mass.

Amer. Foundrymen's Assn. Sec., R. E. Kennedy; Exec. Vice-Pres., C. E. Hoyt, 222 W. Adams St., Chicago, Ill.

Amer. Gas. Assn. Man. Dir., Alexander Forward, 420 Lexington Ave., New York.

Amer. Gum Importers Assn., Inc. Sec.-Treas., George T. Hawxhurst, 360 Furman St., Brooklyn, N. Y.

Amer. Institute of Chemical Engrs. Sec., S. L. Tyler, 50 E. 41st St., New York.

Amer. Institute of Chemists. Sec., Howard S. Neiman, 2110 Woolworth Bldg., New York.

Amer. Institute of Consulting Engrs. Sec., Philip W. Henry; Treas., James Forgie, 75 West St., New York.

Amer. Institute of Electrical Engrs. Nat. Sec., H. H. Henline, 33 West 39th St., New York.

Amer. Institute of Laundering, Drawer 1187, Joliet, Ill.

Amer. Institute of Mining & Metallurgical Engrs. Sec., A. B. Parsons, 29 W. 39th St., New York.

Amer. Institute of Refrigeration. Gen. Sec., J. F. Nickerson, 433 N. Waller Ave., Chicago, Ill.

Amer. Leather Chemists' Assn. Sec.-Treas., C. A. Blair, 143 West 20th St., New York.

Amer. Management Assn. Pres., Alvin E. Dodd; Sec., Henry J. Howlett, 330 West 42nd St., New York.

Amer. Manganese Producers Assn. Pres., J. Carson Adkerson, National Press Bldg., Washington, D. C.

Amer. Museum of Safety. Sec., Julien H. Harvey, 60 East 42nd St., New York.

Amer. Paper & Pulp Assn. Sec., E. W. Tinker, 122 East 42nd St., New York.

Amer. Petroleum Institute. Pres., Axtell J. Byles; Exec. Vice-Pres., W. R. Boyd, Jr.; Sec., Lacey Walker, 50 West 50th St., New York.

Amer. Pharmaceutical Mfrs.' Assn. Sec., S. B. Penick, Jr., 132 Nassau St., New York.

Amer. Photo-Engravers' Assn. Louis Flader, 166 W. Van Buren St., Chicago.

Amer. Physical Society. Sec., Karl K. Darrow, Columbia Univ., New York.

Amer. Potash Inst., Inc. Pres.-Treas., J. W. Turrentine, 1016 Investment Bldg., Washington, D. C.

Amer. Pulp & Paper Mill Superintendents' Assn., Inc. Sec., R. L. Eminger, 54 N. Main St., Miamisburg, Ohio.

Amer. Refractories Institute. Sec., Martha Buerkle, 1418 Oliver Bldg., Pittsburgh, Pa.

Amer. Soc. for Metals. Sec., W. H. Eisenman, 7301 Euclid Ave., Cleveland, Ohio.

Amer. Soc. for Testing Materials. Sec.-Treas., C. L. Warwick, 260 S. Broad St., Philadelphia, Pa.

Amer. Soc. of Bakery Engrs. Sec.-Treas., Victor E. Marx, 1541 Birchwood Ave., Chicago, Ill.

Amer. Soc. of Civil Engrs. Sec., George T. Seabury, 33 W. 39th St., New York.

Amer. Soc. of Heating & Ventilating Engrs. Sec., A. V. Hutchinson, 51 Madison Ave., New York.

Amer. Soc. of Mechanical Engrs. Sec., Clarence E. Davies, 29 West 39th St., New York.

Amer. Soc. of Safety Engrs. (The Engineering Section of the National Safety Council.) Sec., G. E. Burns, 20 N. Wacker Drive, Chicago, Ill.

Amer. Standards Assn. Sec., P. G. Agnew, 29 W. 39th St., New York.

Amer. Water Works Assn. Sec., Harry E. Jordan, 22 East 40th St., New York.

Amer. Welding Society. Sec., Miss M. M. Kelly, 33 West 39th St., New York.

Amer. Wood-Preservers' Assn. Sec., H. L. Dawson, 1427 Eye St., N. W., Washington, D. C.

Amer. Zinc Institute, Inc. Sec., Ernest V. Gent, 60 West 42nd St., New York.

Asphalt Institute. Man. Dir., J. E. Pennybacker, 801 Second Ave., New York.

Asphalt Roofing Industry Bureau. Man. Dir., J. S. Bryant, 2 West 45th St., New York.

Associated Business Papers, Inc., The. Exec. Vice-Pres., S. A. Knisely, 369 Lexington Ave., New York.

Associated Cooperage Industries of America, The. Sec., L. F. Horn, 408 Olive St., St. Louis, Mo.

Assn. of American Soap & Glycerine Producers, Inc. Mgr., R. C. Edlund, 381 Fourth Ave., New York.

Assn. of Consulting Chemists and Chemical Engrs., Inc. Sec., Dr. H. P. Trevithick, 50 E. 41st St., New York.

Assn. of Official Agricultural Chemists. Sec., W. W. Skinner, Box 540, Benjamin Franklin Station, Washington, D. C.

BISCUIT & Cracker Mfrs.' Assn. Sec., R. T. Stokes, 233 Broadway, New York.

Brake Lining Mfgrs.' Assn., Inc. Sec.-Gen. Mgr., C. A. Ekwall, 370 Lexington Ave., New York.

Bureau of Raw Materials for American Vegetable Oils & Fats Industries. Sec., John B. Gordon, 1251 National Press Bldg., Washington, D. C.

Burlap & Jute Assn., The. Sec., R. S. Carraway, 133 W. 21st St., New York.

CALCIUM Chloride Assn. Sec., Ray A. Giddings, 4145 Penobscot Bldg., Detroit, Mich.

Canadian Engineering Standards Assn. Sec., Col. W. R. McCaffrey, Room 3010 National Research Bldg., Ottawa, Ont.

Canadian Institute of Chemistry. Sec., Dr. R. T. Elworthy, 366 Adelaide St., W., Toronto 2, Ont., Canada.

Canadian Institute of Mining & Metallurgy. Sec., E. J. Carlyle, 906 Drummond Bldg., Montreal, Canada.

Canadian Pulp & Paper Assn. Sec.-Mgr., A. E. Cadman, 3420 University St., Montreal, Que., Canada.

Canadian Society of Forest Engrs. Sec.-Treas., A. R. Fenwick, 10 Manor Road, West, Toronto, Ont., Canada.

Carbon Black Export, Inc. Pres., C. E. Kayser, 500 Fifth Ave., New York.

Cellulose Plastics Mfrs.' Assn. Sec., John E. Walker, 631 Tower Bldg., 14th and K Sts., N. W., Washington, D. C.

Ceramic Assn. of New Jersey. Sec., G. H. Brown, Dept. of Ceramics, Rutgers Univ., New Brunswick, N. J.

Chemical Alliance, Inc., The. Sec., W. N. Watson, 608 Woodward Bldg., Washington, D. C.

Chemical Fire Extinguisher Assn. Commissioner, W. J. Parker, 366 Madison Ave., New York.

Chemical Foundation, Inc., The. Sec., Edward J. Muhs, 654 Madison Ave., New York.

Chemists' Club, The. Sec., Robert T. Baldwin, 52 E. 41st St., New York.

Chicago Drug and Chemical Assn. Sec., Walter R. Nay, 128 N. Wells St., Chicago, Ill.

Chicago Perfumery, Soap & Extract Assn., Inc. Sec.-Treas., C. A. Hammond. F. N. Burt Co., Inc., 919 N. Michigan Ave., Chicago, Ill.

Chilean Nitrate Educational Bureau, Inc. Director, H. C. Brewer, 120 Broadway, New York.

Chlorine Institute, Inc., The. Sec., Robert T. Baldwin, 50 East 41st St., New York.

Clay Products Assn. Sec., John D. Cook; Consulting Engr., Robert G. Scott, 111 W. Washington St., Chicago, Ill.

Commodity Exchange, Inc. Sec., Walter Dutton, 81 Broad St., New York.

Compressed Air Institute. Room 1512B, 90 West St., New York.

Compressed Gas Mfrs.' Assn., Inc. Sec.-Treas., Franklin R. Fetherston, 11 West 42nd St., New York.

Copper & Brass Research Assn. Mgr., Theodore E. Veltfort; Sec., Bertram B. Caddle, 420 Lexington Ave., New York.

Corn Industries Research Foundation. Exec. Sec., Pendleton Dudley, 270 Broadway, New York.

DISTILLED Spirits Institute, Inc. Sec.-Gen. Counsel, Howard T. Jones, 1137 National Press Bldg., Washington, D. C.

Drug Chemical and Allied Trades Section, New York Board of Trade, Inc. Sec., John C. Ostrom, 41 Park Row, New York.

EDIBLE Gelatin Mfrs.' Research Society of America, Inc. Sec., H. B. Sweatt, 55 West 42nd St., New York.

Edison Electric Institute. Pres., Charles W. Kellogg; Vice-Pres.-Man. Dir., H. S. Bennion, 420 Lexington Ave., New York.

Electrochemical Society. Sec., Dr. Colin G. Fink, Columbia Univ., New York.

Engineering Institute of Canada, The. Gen. Sec., L. Austin Wright, 2050 Mansfield St., Montreal, Que., Canada.

FEDERAL Wholesale Druggists' Assn., Inc. Sec., R. C. Schlotterer, 147 Nassau St., New York.

Federation of Paint & Varnish Production Clubs. Sec., G. B. Heckel, 901 Cunard Bldg., 220 S. 16th St., Philadelphia, Pa.

Felt Mfgrs.' Assn. Commissioner, W. J. Parker, 366 Madison Ave., New York.

Florida Hard Rock Phosphate Export Assn. Sec., J. M. Extrowich, P. O. Box 157, Savannah, Ga.

Franklin Institute of the State of Pennsylvania, The, and Benjamin Franklin Memorial. Sec.-Dir., Henry Butler Allen, The Benjamin Franklin Parkway at Twentieth St., Philadelphia, Pa.

GLASSINE & Greaseproof Mfrs.' Assn. Sec.-Treas., Thos. J. Burke, 122 East 42nd St., New York.

Greater New York Safety Council, Inc. Exec. Vice-Pres., Tom A. Burke, 60 East 42nd St., New York.

Glycerine Producers' Assn. Mgr., R. C. Edlund, 381 Fourth Ave., New York.

Gypsum Assn. Sec.-Gen. Mgr., H. J. Schweim, 211 W. Wacker Drive, Chicago, Ill.

HYDRAULIC Institute. Room 1512B, 90 West St., New York.

ILLUMINATING Engineering Society. Gen. Sec., Howard M. Sharp, 51 Madison Ave., New York.

Industrial Advertisers Assn. of New York. Sec., Herbert Kaufman, Gen. Printing Ink Corp., 100 Sixth Ave., New York.

Industrial Research Institute. Exec. Sec., Maurice Holland, Engineering Societies Bldg., 29 West 39th St., New York.

Institute of Leather, Cloth & Lacquered Fabrics Mfrs. Sec., C. Stewart Comeaux, 103 Park Ave., New York.

Institute of Makers of Explosives.

Sec., C. Stewart Comeaux, 103 Park Ave., New York.

Institute of Paint & Varnish Research. H. A. Gardner, 1500 Rhode Island Ave., N. W., Washington, D. C.

Institute of Radio Engrs., Inc., The. Sec., Harold P. Westman, 330 West 42nd St., New York.

International Acetylene Assn. Sec., H. F. Reinhard, 30 East 42nd St., New York.

LEAD Industries Assn. Sec., F. E. Wormser, 420 Lexington Ave., New York.

Liquefied Petroleum Gas Assn., Inc. Sec.-Treas., Franklin R. Fetherston, 11 West 42nd St., New York.

MACHINERY and Allied Products Institute. Sec., Alexander Konkle, 221 N. La Salle St., Chicago, Ill.

Manufacturing Chemists' Assn. of the U. S. Sec., W. N. Watson, 608 Woodward Bldg., Washington, D. C.

Mining & Metallurgical Society of America. Sec., Percy E. Barbour, 90 Broad St., New York.

NATIONAL Academy of Sciences. Home Sec., Dr. Fred E. Wright, 2101 Constitution Ave., Washington, D. C.

National Assn. of Cost Accountants. Sec., Stuart C. McLeod, 385 Madison Ave., New York.

National Assn. of Cotton Mfrs. Pres.-Sec., Russell T. Fisher, 80 Federal St., Boston, Mass.

National Assn. of Dyers and Cleaners of the U. S. and Canada. Man. Exec., J. M. Matson, 7901 Georgia Ave., Silver Spring, Md.

National Assn. of Fan Mfrs.. Sec.-Treas., L. O. Monroe, 5-208 General Motors Bldg., Detroit, Mich.

National Assn. of Glue Mfrs.' Inc. Sec., H. B. Sweatt, 55 West 42nd St., New York.

National Assn. of Importers of Hides & Skins, Inc. Exec. Sec., A. M. Helmrath, 100 Gold St., New York.

National Assn. of Insecticide and Disinfectant Mfrs.', Inc. Sec. Ira P. MacNair, 110 East 42nd St., New York.

National Assn. of Mfrs.' Sec., Noel Sargent, 14 West 49th St., New York.

National Assn. of Printing Ink Makers. Sec., David H. Sloane, 1440 Broadway, New York.

National Assn. of Purchasing Agents. Exec. Sec.-Treas., G. A. Renard, 11 Park Place, New York.

National Assn. of Retail Druggists, The. Sec., John W. Dargavel, 205 W. Wacker Drive, Chicago, Ill.

National Canners' Assn. Sec., Frank E. Gorrell, 1739 H St., N. W., Washington, D. C.

National Clean Up and Paint Up Campaign Bureau. Exec. Sec., Ralph W. Emerson, 1500 Rhode Island Ave., N. W., Washington, D. C.

National Electrical Mfrs.' Assn. Man. Dir., W. J. Donald, 155 East 44th St., New York.

National Farm Chemurgic Council. Pres., Wheeler McMillen, 50 West Broad Tower, Columbus, Ohio.

National Fertilizer Assn. Exec. Sec., Charles J. Brand, 616 Investment Bldg., Washington, D. C.

National Fire Protection Assn. Gen. Mgr., Percy Bugbee, 60 Batterymarch St., Boston, Mass.

National Foreign Trade Council, Inc. Vice-Pres., William S. Swingle, 26 Beaver St., New York.

National Industrial Conference Board, Inc. Pres., Virgil Jordan; Sec., Fairfield E. Raymond, 247 Park Ave., New York.

National Industrial Council. Sec., Thomas M. Brennan, 14 West 49th St., New York.

National Lime Assn. Pres.-Gen. Mgr., S. W. Stauffer, 927 15th St., N. W., Washington, D. C.

National Oxygen and Acetylene Assn., Inc. Pres.-Treas., John R. Gobey, 150 E. Broad St., Columbus, Ohio.

National Paint, Varnish and Lacquer Assn., Inc. Sec., Reuel W. Elton, 1500 Rhode Island Ave., N. W., Washington, D. C.

National Paving Brick Assn. Sec.-Engineer, W. H. Cullimore, National Press Bldg., Washington, D. C.

National Petroleum Assn. General Counsel, Fayette B. Dow, 930 Munsey Bldg., Washington, D. C.

National Research Council. Chairman, Dr. Ross G. Harrison, 2101 Constitution Ave., Washington, D. C.

National Safety Council. Man. Dir., W. H. Cameron, 20 N. Wacker Drive, Chicago, Ill.

National Soybean Processors Assn. Pres., Edward Jerome Dies, 3818 Board of Trade Bldg., Chicago, Ill.

National Wholesale Druggists' Assn. Sec., E. L. Newcomb, 330 West 42nd St., New York.

Non-Ferrous Ingot Metal Institute. Sec., R. D. T. Hollowell, 308 W. Washington St., Chicago, Ill.

New York Academy of Sciences. Exec. Sec., Eunice Thomas Miner, 77th St. and Central Park West, New York.

OIL Burner Institute. Pres., R. G. Whipple; Sec.-Treas., C. F. Curtin, 30 Rockefeller Plaza, New York.

Oil Trades Assn. of New York, Inc. Pres., W. H. Correa; Sec., J. C. Smith, 15 Moore St., New York.

PHOSPHATE Export Assn. Pres., Morgan H. Grace; Sec., F. C. Noyes, 393 Seventh Ave., New York.

Portland Cement Assn. Pres., Frank T. Sheets; Vice-Pres., Sec. and Gen. Mgr., William M. Kinney, 33 West Grand Ave., Chicago, Ill.

QUICKSILVER Producers Assn., Inc. Sec.-Mgr., Irving Ballard, 407 Sansome St., San Francisco, Calif.

ROSIN Oil Institute. Commissioner, D. S. Hunter, 2130 Keith Bldg., Cleveland, Ohio.

Rubber Mfrs.' Assn., Inc., The. Pres., A. L. Viles, 444 Madison Ave., New York.

SALESMAN'S Assn. of the American Chemical Industry. Sec., G. S. Furman, F. W. Merk Co., 348 W. 42nd St., New York.

Salt Producers' Assn. Sec., Frank Morse, 2137 Book Bldg., Detroit, Mich.

Scientific Apparatus Makers of America. Pres., J. M. Roberts, 20 N. Wacker Drive, Room 3014, Chicago, Ill.

Society for the Advancement of Management, The. Exec. Sec., Evelyn Buckley, 29 West 39th St., New York.

Society for the Promotion of Engineering Education. Sec., Dr. F. L. Bishop, Univ. of Pittsburgh, Pittsburgh, Pa.

Society of Chemical Industry (American Section). Chairman, Dr. Lincoln T. Work, 120 Broadway, New York.

Sodium Silicate Mfrs.' Institute. Sec., J. Passmore Elkinton, P. O. Box 281 Wm. Penn Annex, Philadelphia, Pa.

Sporting Arms and Ammunition Mfrs.' Institute. Sec.-Treas., C. Stewart Comeaux, 103 Park Ave., New York.

Steel Barrell Mfrs.' Council. Commissioner, D. S. Hunter, 2130 Keith Bldg., Cleveland, Ohio.

Structural Clay Products Institute. Sec., J. J. Cermak, 1756 K St., N. W., Washington, D. C.

Synthetic Organic Chem. Mfrs.' Assn. of the United States. Pres., August Merz, Room 507, 260 West Broadway, New York.

TANNERS' Council of America. Exec. Vice-Pres., Merrill A. Watson; Sec., J. L. Nelson, 100 Gold St., New York.

Technical Assn. of the Pulp & Paper Industry. Sec., R. G. Macdonald, 122 East 42nd St., New York.

Texas Cottonseed Crushers' Assn., Inc. Sec.-Treas., B. Wallin, 1412 Santa Fe Bldg., Dallas, Texas.

Textile Color Card Assn. of the United States, Inc., The. Sec.-Man. Dir., Margaret Hayden Rorke, 200 Madison Ave., New York.

Tile Mfrs.' Assn., Inc., The. 50 East 42nd St., New York.

U. S. ALKALI Export Assn., Inc., Pres., E. V. Finch, 11 Broadway, New York.

U. S. Brewers' Assn. Sec., C. D. Williams, 21 East 40th St., New York.

U. S. Shellac Importers Assn., Inc. Sec., George E. Ashby, 155 John St., New York.

WASHINGTON Academy of Sciences. Sec., Frederick D. Rossini, 1772 North Portal Drive, Washington, D. C.

Water and Sewage Works Mfrs.' Assn., Inc. Sec., John A. Kienle, 60 East 42nd St., New York.

Wood Chemical Institute, Inc. Sec., M. H. Haertel, 823 Albee Bldg., Washington, D. C.

NOTE: Foreign technical societies and associations are listed below. Names and addresses are as they appeared in our previous listings (*Chem. & Met.*, Jan. 1939, p. 59).—*Editor.*

Australian Chemical Institute. Hon. Gen. Sec. W. R. Jewell, Kelvin Hall, 55 Collins Place, Melbourne, C. 1, Australia.

British Assn. for the Advancement of Science, Sec. O. J. R. Howarth, Burlington House, Piccadilly, London, W. 1, England.

British Cast Iron Research Assn. Dir.-Sec., J. G. Pearce, 21-23 St. Paul's Square, Birmingham 3, England.

British Ceramic Society, The. Asst. Sec., F. Salt, The Mellor Laboratories, Shelton, Stoke-on-Trent, England.

British Chemical Plant Mfrs.' Assn. Sec. J. Davidson Pratt, 166 Piccadilly, London, W. 1, England.

British Non-Ferrous Metals Research Assn. Sec. Arthur F. Ridley, Regnart Bldgs., Euston St., London, N. W. 1, England.

Cercle de la Chimie. Sec., Rene Dage, 4, rue Lamblardie, Paris XII, France.

Deutsche Bunsen-Gesellschaft für angewandte physikalische Chemie e.V. Man. Dir., Dr. A. Schweitzer, Steinenhausenstr. 26, Stuttgart—W., Germany.

Deutsche Chem. Gesellschaft. Gen.-Sec. Dr. R. Weidenhagen, Sigismundstr, 4, Berlin W. 35, Germany.

Deutscher Verband für die Materialprüfungen der Technik. Sec. Oberregierungsrat Dipl-Ing W. Deutsch, Dorotheenstrasse 40, Berlin N. W. 7, Germany.

Empire Council of Mining and Metallurgical Institutions. Hon. Sec-Gen., Chas. McDermid, Salisbury House, Finsbury Circus, London, E. C. 2, England.

Faraday Society, The. Sec., G. S. W. Marlow, 13 South Square, Gray's Inn, London, W. C. 1, England.

Hawaiian Sugar Planters' Assn. Director of Experiment Station, H. L. Lyon, Honolulu, Hawaii.

Institute of Metals. Sec., G. Shaw Scott, 4 Grosvenor Gardens, Westminster, London, S. W. 1, England.

Institute of Petroleum. Sec., S. J. Astbury, M. A., The Adelphi, London, W. C. 2, England.

Institution of Chemical Engineers, The. Joint Hon. Sec's., A. J. V. Underwood and M. B. Donald, 56 Victoria St., London, S. W. 1, England.

Institution of Mining & Metallurgy. Sec., Charles McDermid, Salisbury House, Finsbury Circus, London, E. C. 2, England.

Institution of Mining Engrs. Sec. Charles McDermid, Salisbury House, Finsbury Circus, E. C. 2, England.

International Society of Leather Trades' Chemists. Hon. Gen. Sec., Dr. J. Gordon Parker, 17 Leathermarket St., London, S. E. 1, England.

Iron & Steel Institute. Sec., K. Headlam-Morley, 4 Grosvenor Gardens, London, S. W. 1, England.

Junior Institution of Engrs., Inc. Sec., Herbert G. Riddle, 39 Victoria St., Westminster, S. W. 1, England.

Oil & Colour Chemists' Assn. Editor-Sec., G. Copping, 8, Ludgate Broadway, London, E. C. 4, England.

Rubber Growers' Assn., Inc., The. Sec., Frank G. Smith, 19 Fenchurch St., London, E. C. 3, England.

Societe de Chimie Industrielle. Vice-Pres., Delegate, Jean Gerard, 28, Rue Saint-Dominique, Paris, France.

Society of Chemical Industry. Sec., H. J. Pooley, Clifton House, Euston Road, London, N. W. 1, England.

Society of Dyers & Colourists. Sec., J. B. Atkinson, 32-34 Piccadilly, Bradford, England.

Society of Glass Technology. Sec., Prof. W. E. S. Turner, Northumberland Road, Sheffield 10, England.

South African Chemical Institute. Hon. Sec., J. A. McLachlin, M. Sc. Eng. (Rand), P. O. Box 3361, Johannesburg, South Africa.

Union Internationale de Chimie. Sec., Jean Gerard, 28 Rue Saint-Dominique, Paris, France.

Timesaving Ideas for Engineers

Chem & Met PLANT NOTEBOOK

HOW TO CALIBRATE HORIZONTAL CYLINDRICAL TANKS EQUIPPED WITH NON-STANDARD ENDS

CHESMAN A. LEE Engineer, Evanston, Ill.

CALIBRATION of horizontal cylindrical tanks with dished ends is a subject that has already occupied a good deal of space in the technical literature, for which reason the writer hesitates to open the matter again. There is however a factor involved in most methods previously published which prevents their having widest applicability. These methods are based on standard tanks in which the radius of the dished ends is equal to the diameter of the cylindrical portion of the tank, whereas there are a good many tanks in existence having an end radius either larger or smaller than the tank diameter. Then again, it is desirable to be able to derive the calibration curve for a given tank, even if standard, when tables or charts for this purpose* are not available.

Simple Geometry Used

The method proposed depends upon the simple geometry of the dished end. In the accompanying drawings, Fig. 1 is a perspective of one end of the tank showing the liquid level standing at height *y* above the bottom. Fig. 2 is a cross section of the tank end which is to be used graphically in determining the volume of liquid in the end for various levels. For this purpose the tank end is laid out to a convenient scale, such as 1 in. equals 1 ft. The problem now is to determine the actual shape and area of the exposed upper surface of the liquid, when the liquid height is *y*. The area is that shown cross hatched in Fig. 1. This is done by considering Fig. 2 first as the elevation and then as the plan of the tank end. The point where the level *y* touches the end is projected to the tank center line and then the view is rotated mentally through 90 deg. to become the plan. The distance from this projected point to the center of rotation of R′, the radius of the end, is R″, the radius of the shaded segment which represents the liquid surface. That the shaded segment so obtained is actually the liquid surface for height *y* will be evident if one considers a sphere of radius R′, in which liquid stands at any height other than R′. The liquid periphery will be a circle with its center on the vertical center line of the sphere, and its radius equal to the horizontal distance to the sphere.

The area of the shaded segment can be evaluated in various ways. Most engineering handbooks contain tables for the area of a segment in terms of *h*, the height of the segment, and *c*, the length of the chord. If such tables are at hand, scale the drawing for *h* and *c* and determine the area directly. If the tables are lacking, the calculation of the area is one of simple geometry if a protractor is available, or of trigonometry if a table of tangents is at hand. Such calculations are tedious, however, and a somewhat less accurate graphical approximation can be employed. Taking half of the segment, construct a triangle of base *a* and altitude *b* such that its area approximates that of the half segment. Then the area of the whole segment will be *a* x *b*.

To make the calibration the areas of several segments corresponding to a number of liquid levels between zero and half the tank diameter must be determined, each as shown above. These levels need not be at regular intervals, but enough of them must be taken to permit a good degree of accuracy in drawing the curve of Fig. 3. This curve is a plot of the areas of the several segments, against the height of the liquid level. When it has been smoothed it represents at any point the area of the liquid surface in the tank end when the liquid height is as shown. It is now possible to make a table of liquid volumes in the end for the various heights up to half the tank diameter.

This is done by the summation of volumes contained in the end between a number of closely spaced liquid levels. To avoid multiplication the area scale of Fig. 3 should be expressed in square inches. Then the volume in cubic inches between levels 1 in. apart is very nearly equal to the mean area of each thin slice of tank contents. Using the chart prepared by the method of Fig. 3, read off the area at each 1 in. level from the bottom to the tank center line. Starting at the bottom at zero add each volume between the 1 in. increments, recording the accumulated volume at each level. An adding machine with a visual totalizer is convenient for this purpose. Make a second tabulation multiplying the values in the first column by 2, to give the volume in both ends. As a check of the volume at the midpoint, calculate what this should be from the formula $V = (\pi h/6)(3a^2 + h^2)$, where V is the total volume of one end, or the half volume of two ends, h is the height of the total end segment, and a is the half chord, or R.

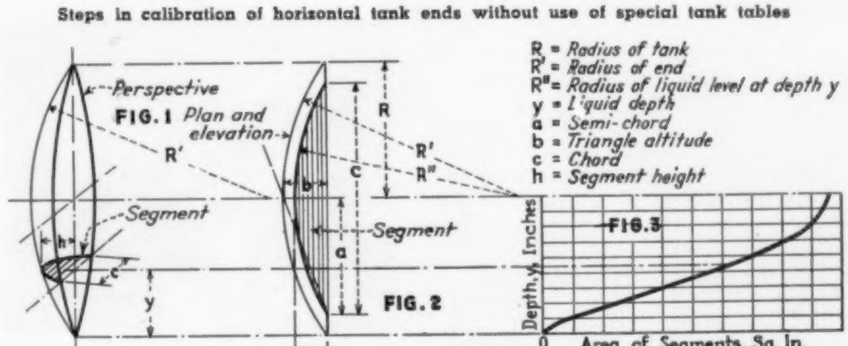
The tabulation now may be converted to whatever units the completed calibration is to have, such as cubic feet, or gallons. For the former divide by 1,728, for the latter, by 231.

Calibrating Cylindrical Part

The main body of the tank must now be calibrated for each inch of depth up to the center line. This may be done in various ways. Handbooks such as Perry's give tables of volumes per inch of depth and foot of length. Or with a table of areas of segments, the volumes at a number of depths can easily be calculated and plotted, so that the volumes at each inch of depth can be read from the curve. Or, the segment areas can be calculated by the triangle method, or by geometry or trigonometry, as mentioned above. At any rate, a volume curve should be drawn for the cylindrical portion of the tank, using the same units, such as cubic feet or gallons, decided on for the final calibration. Then the volumes for each inch of depth are read off and added to the corresponding volumes for the two ends in the tabulation, this last volume representing the total volume of the tank.

To continue the calibration table for the upper half of the tank it is simply necessary to subtract the volumes in the lower half from the total volume of the tank. For example, the volume at a level 2 in. above the center line is equal to the total volume minus the volume at a level 2 in. below the center line.

Steps in calibration of horizontal tank ends without use of special tank tables



* For instance, see Sullivan's "Sulphuric Acid Handbook," Standard Car Construction Co.'s handbook, "All About Tank Cars," or Davis' nomograph, *Chem. & Met.*, p. 602, Nov. 1934. Perry's "Chemical Engineers' Handbook" gives tables, but only for cylindrical portion of tank.

Chem & Met Process Equipment NEWS

Machinery, Materials and Products

Plastic Packing

AN IMPROVEMENT in this company's Super-Seal plastic packing has been announced by the Crane Packing Co., 1800 Cuyler Ave., Chicago, Ill. This packing is now being made with a patented tape back reinforcement, securely vulcanized to the outer surface of the packing. The new reinforcement replaces the older type frictional woven cotton jacket. In the new type a non-frictional surface bears directly against the moving part. This packing is said to be extremely pliable so that it can be bent around small diameter rods and shafts without fracturing or cracking. It is a dry-graphitized type, made of long-fiber asbestos, anti-frictional metal particles, and special binders. Made in six types it is said to cover all varieties of services, and to be available in sizes from ¼ to 1 in., graduated by sixteenths, for use on pumps, engines, valve stems, expansion joints and similar service.

Redesigned Motors

GENERAL ELECTRIC CO., Schenectady, N. Y., has announced a complete new line of polyphase induction motors, known as the Tri-Clad series, which has involved one of the most extensive product changes in the history of the company. Many improved features are employed. Of streamlined appearance, the motors employ cast iron frames designed to give more complete protection than has heretofore been available except in especially inclosed models. Improved bearing design, lubrication arrangements and insulation are other features. A cast aluminum rotor is employed, together with a pressure-relief system of greasing for ball bearing motors. Both ball bearing and sleeve bearing types are available.

The new cast iron frame is of the box type with end shields designed to minimize contacts of the motor parts with foreign material. The motor is wound with the new Formex magnet wire which results in packing a maximum amount of wire into the available space. On this account, motors of a given size are considerably smaller than heretofore.

Another basic improvement is in the design of the sleeve bearings. An extensive investigation disclosed that bearing loads can be doubled over those of conventional design by choosing the proper proportion of length to diameter of the sleeve. In general, the new bearings are shorter for a given diameter than those used in the past. A new type of grooving is employed. Other features include improved wiring facilities and convertibility of sleeve-bearing motors to ball bearing and vice versa.

Lifting Fork Truck

A RECENT DEVELOPMENT of the Clark Tructractor Div. of Clark Equipment Co., Battle Creek, Mich., is a new lifting, carrying and tiering fork truck which will handle loads as heavy as 7,000 lb. and tier them in piles 15 ft. high and higher. The new machine, known as the Utilitruc, is gas-powered and is made in several models, including straight lift, tilting, and telescopic tiering. It is equipped with chisel-pointed fingers, permitting the picking up of uncleated loads. The operator picks up the desired load, lifts it clear of the floor, tilts it back 10 deg. for safe carrying, elevates it at the rate of 7 in. per second, tilts it forward 3 deg. for tiering, and thus unloads. Hydraulic brakes, rear wheel steer and a heavy duty engine for speeds from 1 to 7 m.p.h. are standard equipment. The lifting mechanism is hydraulic.

Tape-reinforced plastic packing

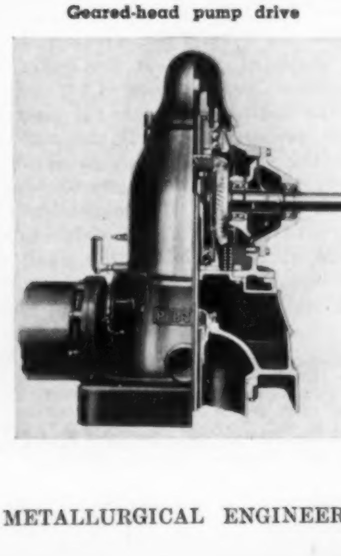
New Tri-Clad motors

Pump Drive

TO PROVIDE for the driving of deep-well pumps by gas and steam engines and other power units, the Peerless Pump Co., 301 West Ave. 26, Los Angeles, Calif., has announced an improved pump head of the geared type in which several new features are incorporated. The take-off shaft is designed to carry increased loads. Double-row ball bearings support the horizontal and vertical shafts and are placed adjacent to the spiral bevel gears. An extra heavy-duty thrust bearing is provided to support the lower end of the geared shaft sleeve, while an additional thrust bearing supports the outer end of the horizontal drive shaft. Oil pressure lubrication, employing circulating cooled oil, supplies both bearings and gears. An improved oil seal is placed on the end of the bearing housing. Four speed ratios between 1 to 1 and 2 to 1 are available.

Gas-powered tiering truck

Geared-head pump drive



Infra-Red Lamp

NUMEROUS drying and baking operations, according to the manufacturer, can be handled more expeditiously than by other methods through the use of radiant heating with the new infra-red Thermalamp recently developed by the C. M. Hall Lamp Co., 1035 Hancock Ave. East, Detroit, Mich. This lamp, a new type of sealed-beam infra-red source, consists of a special Mazda bulb of 1,000 watts, mounted in a 24K gold plated reflector equipped with a lens for heat distribution control and glare elimination. Pre-wired channels are provided, equipped with properly placed sockets for the Thermalamps, and are easily mounted on an ordinary pipe framework to form an oven of any desired dimensions. These lamps are capable of applying heat at an intensity of approximately 10 watts per sq.in. At present the practical temperature limit is about 600 deg. F. Advantages cited for radiant heating include the fact that the heat can be applied directly to the work without loss of much heat through convection. Low first cost and ease of moving and rearranging the oven structure are other advantages.

Cab-Type Carrier

ONE OPERATOR can take care of all operations involved in moving materials over an overhead tramrail system by means of a new type of tramrail carrier with raise-lower cab, recently announced by the Cleveland Tramrail Div. of Cleveland Crane & Engineering Co., Wickliffe, Ohio. This equipment is available in two general forms. One form provides for the raising and lowering of the cab and load together. The other makes possible independent raising and lowering of cab and load. If the materials are of such nature that a lifting fork is needed, one operator can also handle such a job just as with a crane hook.

In the unit illustrated, where cork is handled, during the day shift large quantities of cork are required and the cab is kept in the upper position. Three men are then employed, one for attaching loads, one for detaching at the receiving end, and one for operating the tramrail unit. During the night shift, however, demand for materials is not so great and the cab operator alone takes care of the entire job. This unit has a vertical travel of 40 ft. for both cab and hook, but such equipment can be furnished for operation from much greater heights, if desired. Safety, with the operator above the load, and speed of operation, are advantages claimed. Such materials as kegs, drums, rolls of paper, cement and other pulverized materials, are typical of the products that may be handled, according to the manufacturer.

Experimental Thermalamp installation

Carrier with raise-lower cab

Combustible Gas Alarm

CONTINUOUS SAMPLING of atmospheres where combustible gases and vapors may be present, with complete safety, is the function of a new self-contained explosion-proof combustible gas alarm developed by Mine Safety Appliances Co., Braddock, Thomas & Meade Sts., Pittsburgh, Pa. The unit provides an instantaneous warning when gas concentrations exceed predetermined limits and may be adapted for automatic process or ventilation control. Installation is said to be greatly simplified as compared with devices having a separate detector head case. The instrument itself is of the type employing a balanced electrical circuit in which are two heated platinum filaments. The sample, drawn over one of the filaments, burns when combustibles are present, thus increasing its temperature and its resistance and unbalancing the circuit in proportion to the concentration of combustibles present. A new type diaphragm pump with a non-sparking motor armature and an explosion-proof case is employed for sampling. The instrument may be connected to a recording potentiometer, if desired, to produce a continuous record of gas concentration.

Explosion-proof gas alarm

Electronic level control

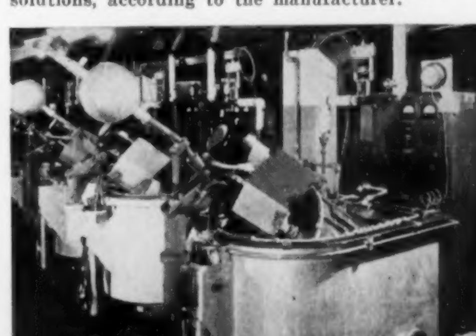
Electronic Level Control

A NEW DEVELOPMENT of Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass., is an electronic level control designated as Type P30. The new control is said to be suitable for both conductive and non-conductive liquids, as well as powders. Various types are available for single level control, on-and-off control of two levels, boiler feedwater control and tank condensate signalling. Installation merely entails attaching a probe fitting to the surface of the tank. Having no moving parts, the equipment is said to have unlimited life and maximum simplicity.

For two-level control, the probe fittings or electrodes are attached to the tank at levels representing the low point where the pump starts, and the high level where the pump stops.

Rubber-Lined Electroplating Tanks

View of part of an installation of 12 high-speed electroplating tanks being used at a temperature of 180 deg. F. in the plant of Westinghouse Electric & Mfg. Co. at Newark, N. J. The tanks are lined with the recently announced Triflex "K" rubber tank lining, developed by the B. F. Goodrich Co., Akron, Ohio. This lining, intended especially for this type of service, is non-contaminating and completely resistant to the action of the plating solutions, according to the manufacturer.



These probes are wired to the control unit. So small a current and so low a voltage are required in operation of the instrument that it is claimed to be safe for combustible liquids, and to function satisfactorily with such insulators as oils, lacquers, thinners, paraffins, mica, cement and similar materials.

Novel Speed Reducer

WHAT IS SAID to be a completely new method of speed reduction has been introduced by the American Pulley Co., Philadelphia, Pa. The new equipment consists of two major elements: a helical-gear reduction unit mounted directly on the shaft of the driven machine, and a standard belt drive between the motor and the input shaft of the reduction unit. The unit has a standard fixed ratio of 13 to 1, any greater or lesser ratios being accomplished by the primary belt drive. Five reduction units, each with the same speed reduction ratio, cover applications from ½ to 30 hp. Any desired speed may be obtained in the range from 11 to 215 r.p.m. with standard stock equipment.

Owing to the mounting of the new unit directly on the shaft, special foundations are not required. Necessary maintenance attention is confined to infrequent lubrication. When the drive is equipped with one of this company's Tension-Control motor bases, the over-all efficiency is said to come close to the 98½ per cent efficiency claimed for the reduction unit itself.

Sluicing Filter Press

IN ORDER to save time and labor in removing the filter cake after filtration has been completed, T. Shriver & Co., 850 Harrison St., Harrison, N. J., has developed a new quick-cleaning or sluicing type of filter press which is similar to ordinary types except that it is designed to permit removal of the cake from the several chambers by sluicing out as a thin slurry, using water introduced behind the cloths. Thus it is claimed that a long series of runs can be made without opening the filter for cleaning. The time required for sluicing is much shorter than ordinarily needed for opening and manually cleaning a filter of the same size. Since sluicing involves only the manipulation of a few valves, one man can clean the largest filter with ease, according to the manufacturer.

Operation of the new filter is similar to an ordinary filter press up to the point of removing the cake. When the chamber is full, filtration is stopped and the remaining liquid drained off. Water at from 30 to 50 lb. pressure is then introduced and the drain cocks in the frames opened, one by one. Backward flow of water through the filter loosens the cake and removes it through the drain cock. It is claimed that the filtrate yield using the sluicing method is as much as 30 per cent greater than that from filtration involving manual cleaning. Disposal of the cake is facilitated by its being in slurry form as removed from the filter press. In the small 12-in. press illustrated, a single large outlet cock is employed for sluicing. On larger filtering units, individual outlet cocks are installed on each frame.

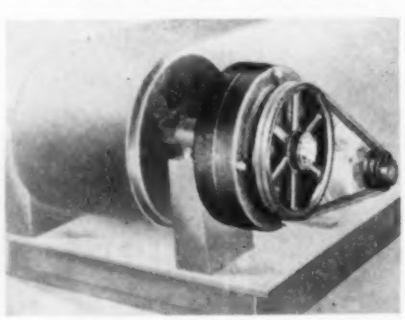
Equipment Briefs

FOR HANDLING load capacities up to 4,000 lb., The Yale & Towne Mfg. Co., Philadelphia Div., Philadelphia, Pa., has announced the new model Y4RP-9 hand-operated pallet truck, which features a multiple-stroke lifting mechanism to give effortless lift. A positive lock and hydraulic release check are used. The truck is intended to facilitate hand trucking operations, and to serve as a supplement to electric truck handling, for short hauls and in confined quarters.

TWO NEW oil-immersed electrical controls have been announced by General Electric Co., Schenectady, N. Y. One, the new Type SF-1 disconnecting switch, is given a 5,000-volt, 600-amp. rating and is intended particularly for explosive and corrosive atmospheres, in oil refineries and chemical plants. Many safety features are incorporated. For example all terminals and connections are at least 6 in. under the oil, while an interlock prevents opening of the switch under short circuit or load. The company has also developed a new oil-immersed combination a-c starter for use in corrosive or explosive atmospheres, available with or without a circuit breaker. Stainless steel and Monel metal are used for all exposed parts, with copper-bearing steel for the tank and a cast-iron head. An extra deep tank is employed for explosion-proof control.

FOR USE in plants where animal or vegetable oils or other rubber-deteriorating elements may be present on floors, the Lehigh Safety Shoe Co., Allentown, Pa., has introduced a line of boots and shoes in which the vamp and sole are of neoprene. The sole is made in one flat piece from toe to heel, doubling normal traction area and assisting the special grid pattern of the sole in preventing slipping. For extreme conditions, all-neoprene boots are available, without the special safety sole feature.

Shaft-mounted speed reduction unit

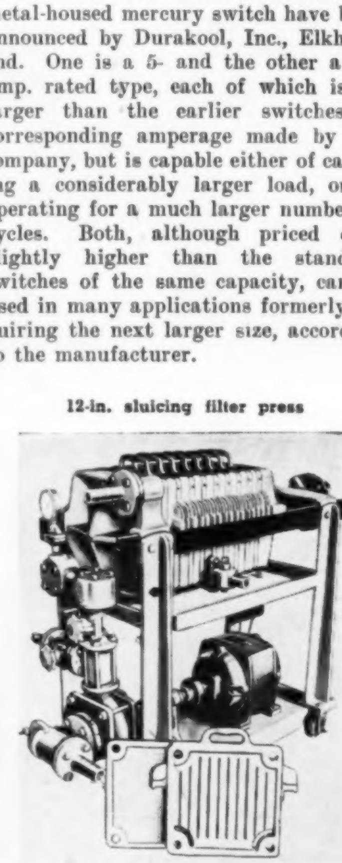


TWO NEW program clocks, one to operate a signal at any five-minute period, and the other at any one-minute period within 24 hours, are now being manufactured by Zenith Electric Co., 845 South Wabash Ave., Chicago, Ill. The clocks have a 24-hour dial and a 1-hour dial cam. Pointers connected to a contact arm ride on the dials and permit the contact arm to fall only when the preset time is reached. Use of heavy duty synchronous motors is said to assure absolute accuracy. The clocks are available for many different purposes.

TWO IMPROVED thermostats recently developed by Fenwal, Inc., Ashland, Mass., have been introduced under the names of Air and Immersion Thermoswitches. Both types are similar in their principal construction features, comprising a thermostat adjusted by means of a pointer moving over a dial, inclosed in a junction box to which BX leads or conduit may be attached. Both types are available in various ranges such as —50 to 400 and —50 to 600 deg. F., and in ratings from 10 to 25 amp. capacity at 110 v. The air type is for installation in air ducts, while the immersion type stem is equipped with a hex head and thread for screwing into a liquid container.

TWO NEW models of its unbreakable metal-housed mercury switch have been announced by Durakool, Inc., Elkhart, Ind. One is a 5- and the other a 10-amp. rated type, each of which is no larger than the earlier switches of corresponding amperage made by the company, but is capable either of carrying a considerably larger load, or of operating for a much larger number of cycles. Both, although priced only slightly higher than the standard switches of the same capacity, can be used in many applications formerly requiring the next larger size, according to the manufacturer.

12-in. sluicing filter press



FACTS YOU NEED TO KNOW ABOUT . . .

Long-Tube Vertical Evaporators

For the rapid concentration of thin, foamy liquors where scaling is not encountered

Vertical type evaporators differ from horizontal type evaporators in that the heating tubes are located in a vertical position, and in that the boiling liquor is inside the tube and the heating steam surrounds it. The long-tube type evaporator is different from the calandria and basket vertical-tube types in that the tubes are longer—usually from 50 to 100 times the tube diameter.

ADVANTAGES

In the long-tube vertical (L.T.V.) evaporator, the velocity of the boiling liquor (and hence the rate of heat transfer) is greater than in other natural-circulation evaporators, because of the strong pumping action of the long tubes when operated at low levels. In addition, the long cylindrical steam chest gives good steam velocities and positive displacement of air, which further increases heat transfer. As a result, for a given entrainment rate, the L.T.V. evaporator has the highest capacity per unit of heating surface, especially in the evaporation of thin, foamy liquors.

LIMITATIONS

As a class, vertical-tube evaporators are practically the only ones that can be used when scale forms; because the removal of scale from the inside of a tube is fairly simple, while its removal from the outside is relatively difficult. However, if scale is formed during evaporation, the L.T.V. is at a decided disadvantage, unless the scale can be removed by chemical means or through boilout. Other vertical-tube units can be scaled with a mechanical tube cleaner, if necessary, but it is not considered practical to mechanically clean the long small tubes of the L.T.V.

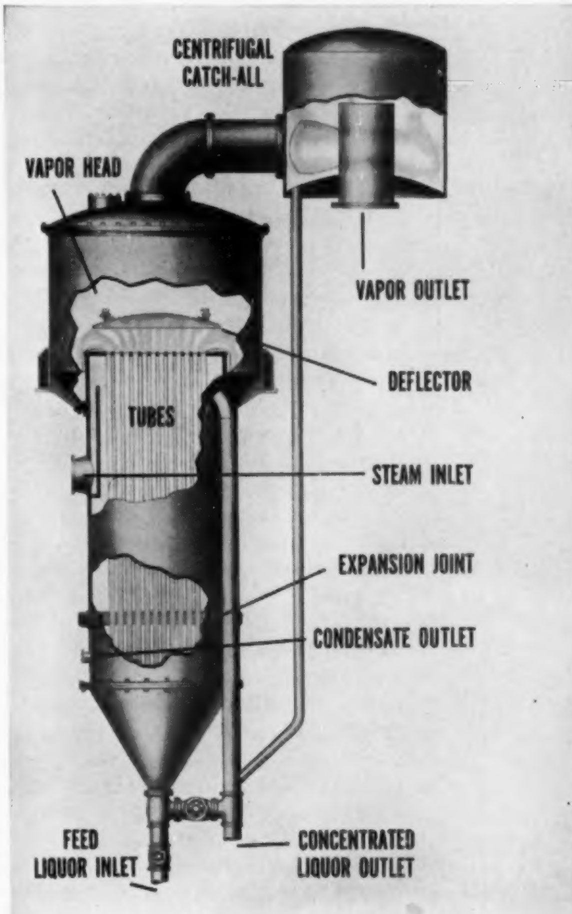
The inconvenience of making tube replacements and the considerable head room required are other disadvantages of the L.T.V.

APPLICATIONS

At present the trend has been decidedly in favor of the forced-circulation evaporator when scale or salt may form, and the natural-circulation L.T.V. evaporator for clear liquids. The L.T.V. has been used widely in straight concentration problems of the chemical industry. It is also extensively used on black liquor recovery in pulp mills and for concentrating heat-sensitive substances like glue and gelatin.

A large saving can often be made by using the multiple-effect principle. Here, two or more evaporators are connected together so that the vapor from the first is used to evaporate the liquor in the next, at a lower pressure. Adding effects does not change the capacity of the complete unit, but increases the steam economy. In determining how far to go, it is necessary to balance the value of the steam saved against the cost of each additional effect.

SWENSON offers a complete line of long-tube vertical evaporators, as well as other types, for every operating condition. Write for information.



PRINCIPLE OF OPERATION

Liquor enters at the bottom and is heated by steam surrounding the tubes. Vapors rise to the vapor head, where a gross separation from the liquor takes place, and pass into the catch-all for final separation. Liquor is returned to the tubes, the next effect, or the discharge pump.

Swenson Quintuple-Effect, L. T. V. Evaporator for kraft mill black liquor.

SWENSON EVAPORATOR COMPANY

Division of Whiting Corporation • *15669 Lathrop Ave., Harvey, Ill.*

SWENSON

EVAPORATORS

FILTERS • CRYSTALLIZERS

Zinc Oxide Production

THE ORE from which St. Joe zinc oxides are produced originates in the northern part of New York where the St. Joseph Lead Co. owns and operates zinc mines at Edwards and Balmat, St. Lawrence County. After mining and milling, the zinc concentrates are shipped to the company's smelter at Josephtown, Pa., where the oxide is produced by a patented electrothermic process.

At the roaster plant the concentrates, together with dust from the sintering operations and zinc sulphate from the leach plant are roasted in a multiple hearth Herreshoff roaster. The ore, now called "calcines," is conveyed by water-cooled screws to a belt conveyor.

At the sinter department the calcine is mixed with flux, fuel, water and residue from the furnace plant. This mixture is charged into a sintering machine and heated at 1,600 deg. C. The main portion of the sinter is discharged in the form of large cakes. These are crushed and sized by means of rolls and screens before being sent to the furnace plant.

Sinters and coke are weighed, preheated and then treated in large resistance furnaces. The new furnaces have a capacity of 55 tons. The atmosphere in the furnaces is composed of zinc vapor and carbon monoxide gas. The zinc vapor oxidizes to ZnO and the CO to CO_2. Oxide carrier air and gases are collected in manifolds, passed through a large fan, thence through a cyclone separator and following this gases and air filter through bag filters which retain the oxide. The bags are automatically shaken down at regular intervals. The oxide is collected, graded, screened, and packed, whence it is sent to storage or shipped direct to customer.

The essential operations in the process for the production of zinc oxide as carried out in the Josephtown plant of the St. Joseph Lead Co. are shown in the accompanying diagrammatic and pictorial flowsheet.

CHEMICAL & METALLURGICAL ENGINEERING

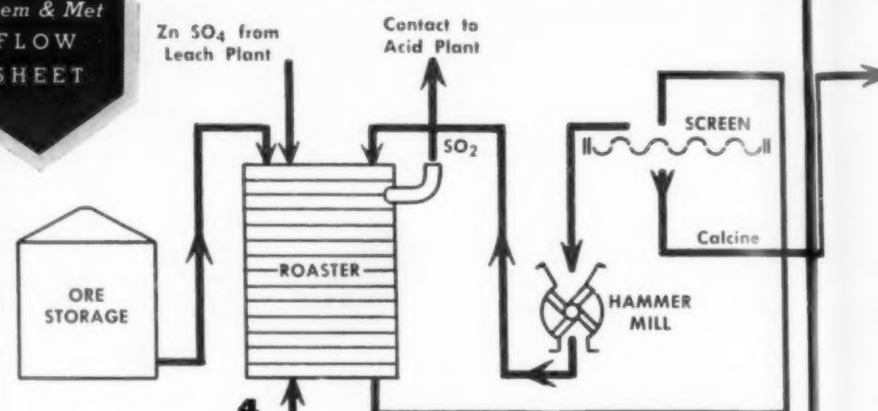
February, 1941

PAGES 142-2 to 145-2

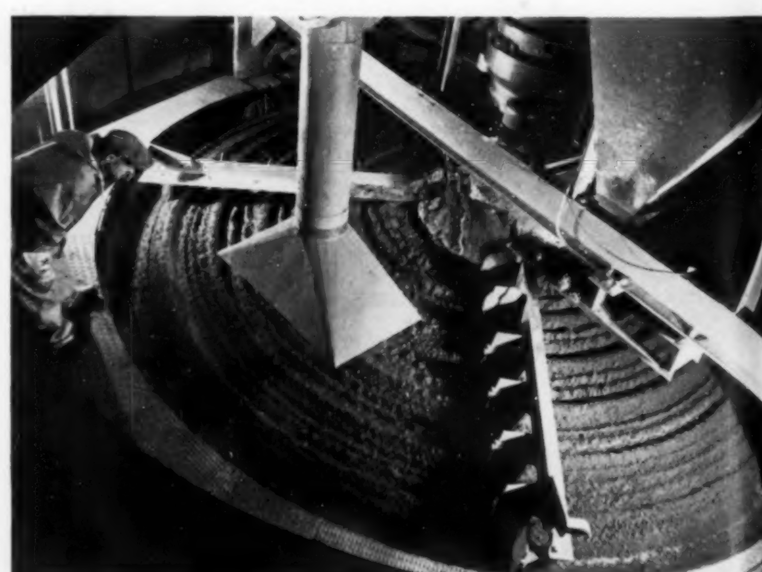
A
Chem & Met
FLOW SHEET

1 A stope in the Balmat zinc mine of the St. Joseph Lead C
St. Lawrence County, New York. Veins have a dip of about 45

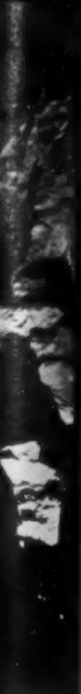
2 L
from



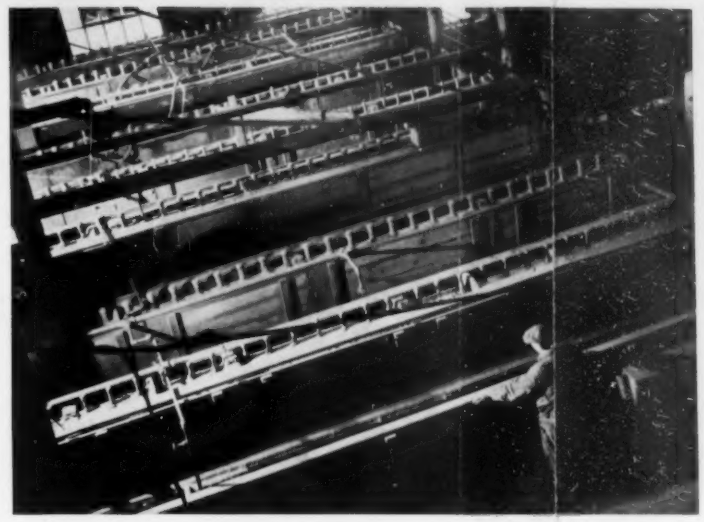
ROASTER PLANT



4 Charging hearth of roaster. Concentrates are roasted to reduce sulph
Resultant calcine contains 67 to 68 percent zinc



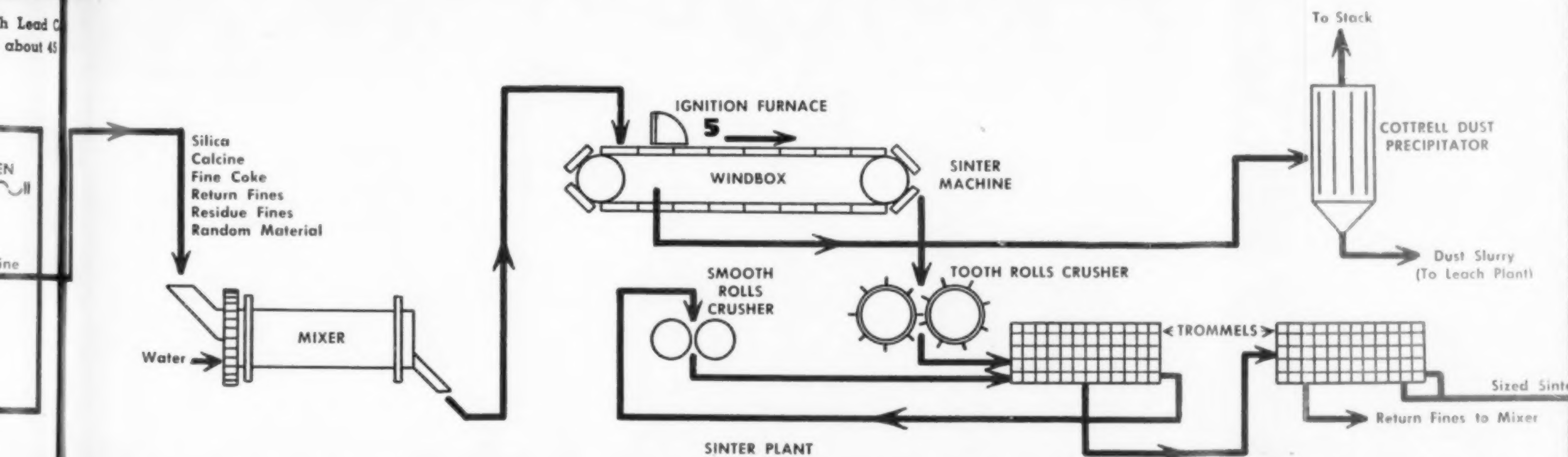
2 Loading ore trains in the mine. These trains dump ore into underground pockets from which it is later drawn off and hoisted 2,000 ft. up the inclined shaft



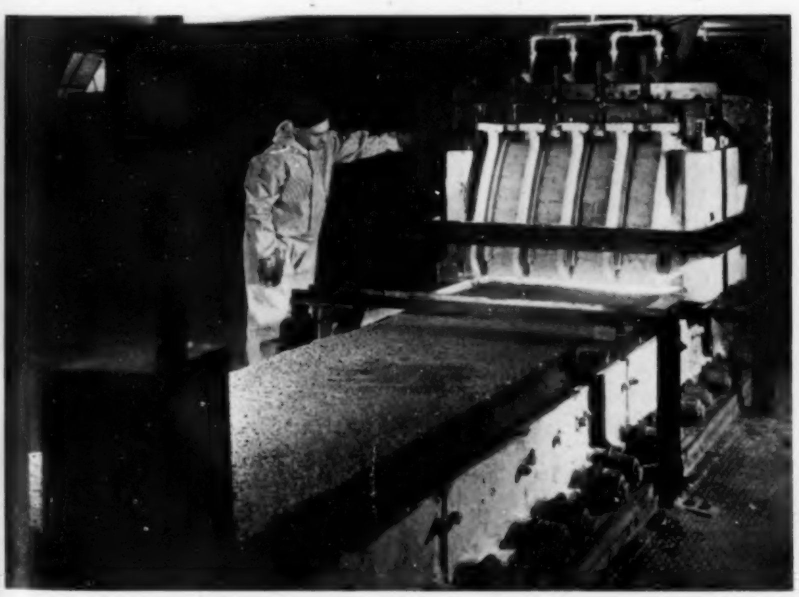
3 Ground ore and water with chemical reagents are agitated in St. Joe flotation machines. Zinc sulphide is floated from pyrites

7 Preheat[...]
brick-lined [...]

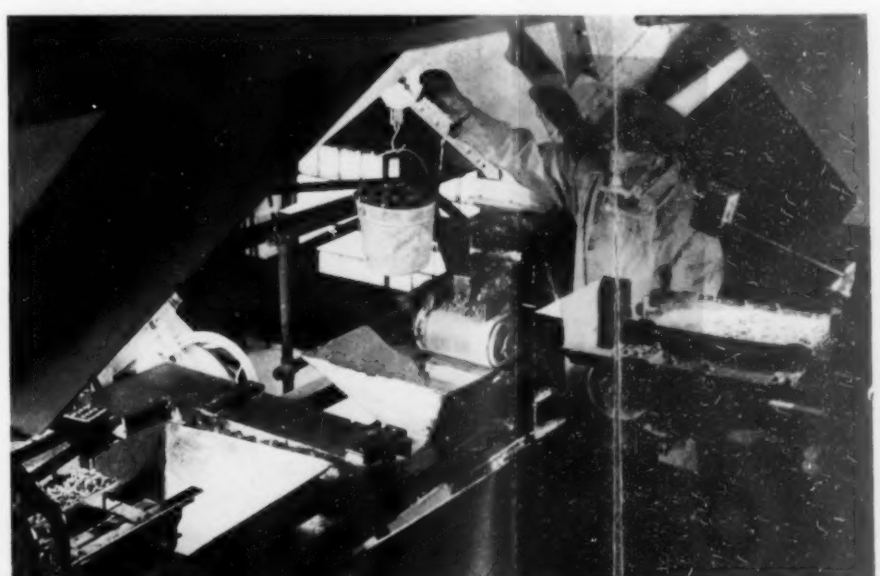
h Lead C[...]
about 45[...]



[...]ce sulph[...]

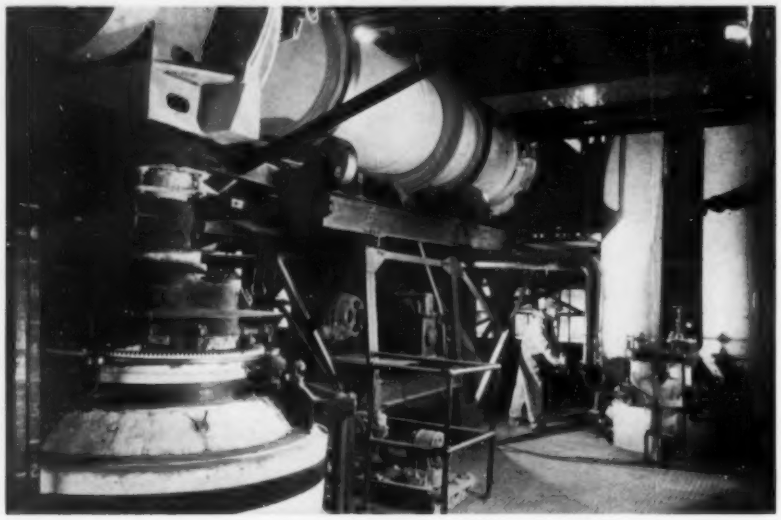


5 Sintering of the calcine is done on gas-fired machines. After screening, this material is conveyed to furnace bins where it awaits treatment

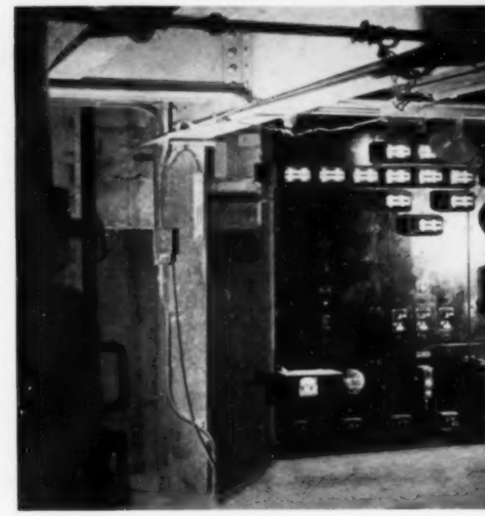


6 Automatic weighing machines for zinc sinter and coke, and for control of feed to preheater. The preheated charge is fed continuously into the furnaces

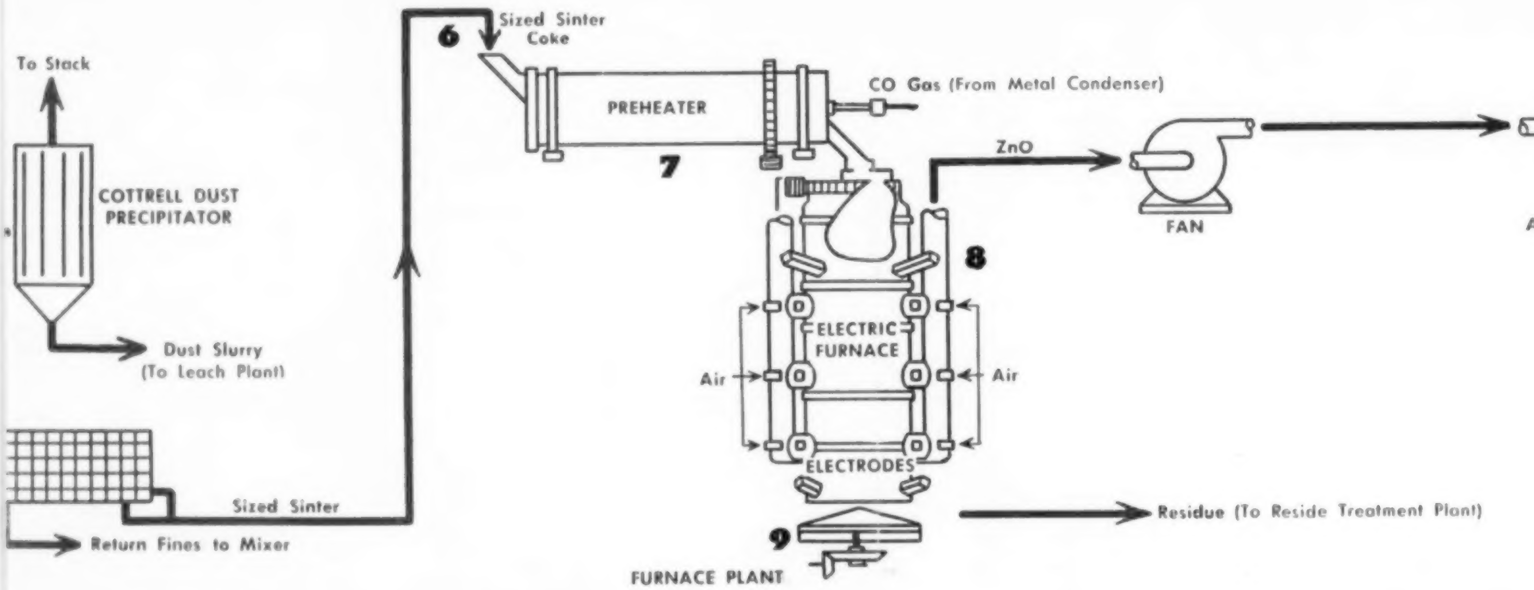
e agitated in
from pyrites



7 Preheater and top of electrothermic furnace. The preheater is a gas-fired brick-lined kiln in which the temperature is raised to dull red heat

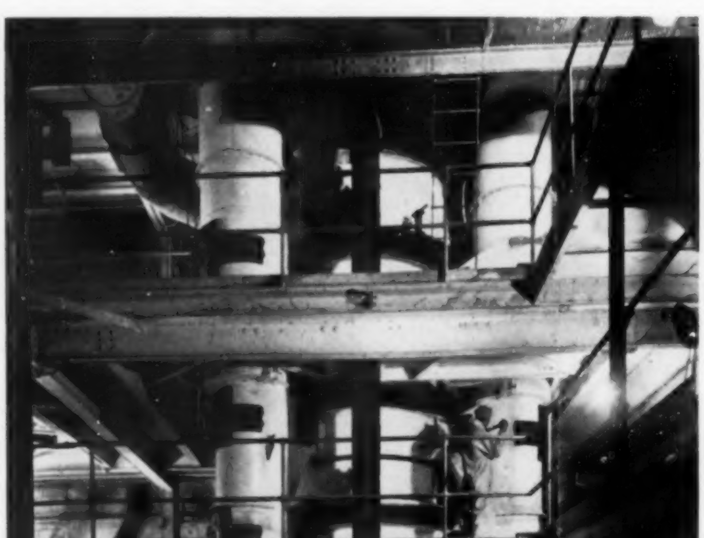


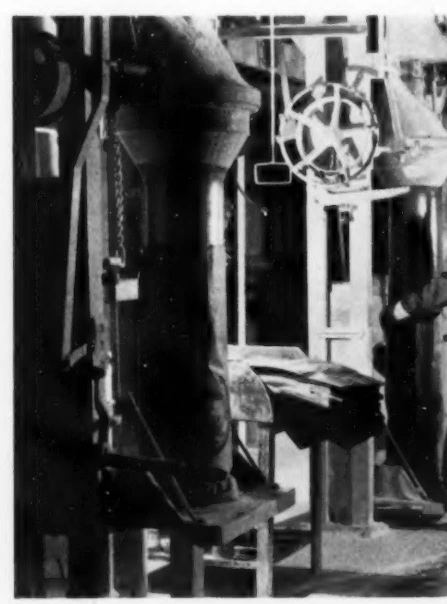
8 Panel board and operating controls for electrica
town plant of the St. Joseph Lead Co.



9 Electrothermic furnace in which the charge serves as the current carrying medium. It rises to a temperature of about 1,200 deg. C. and becomes incandescent. The charge is fed into the top

nd for control of feed to
furnaces

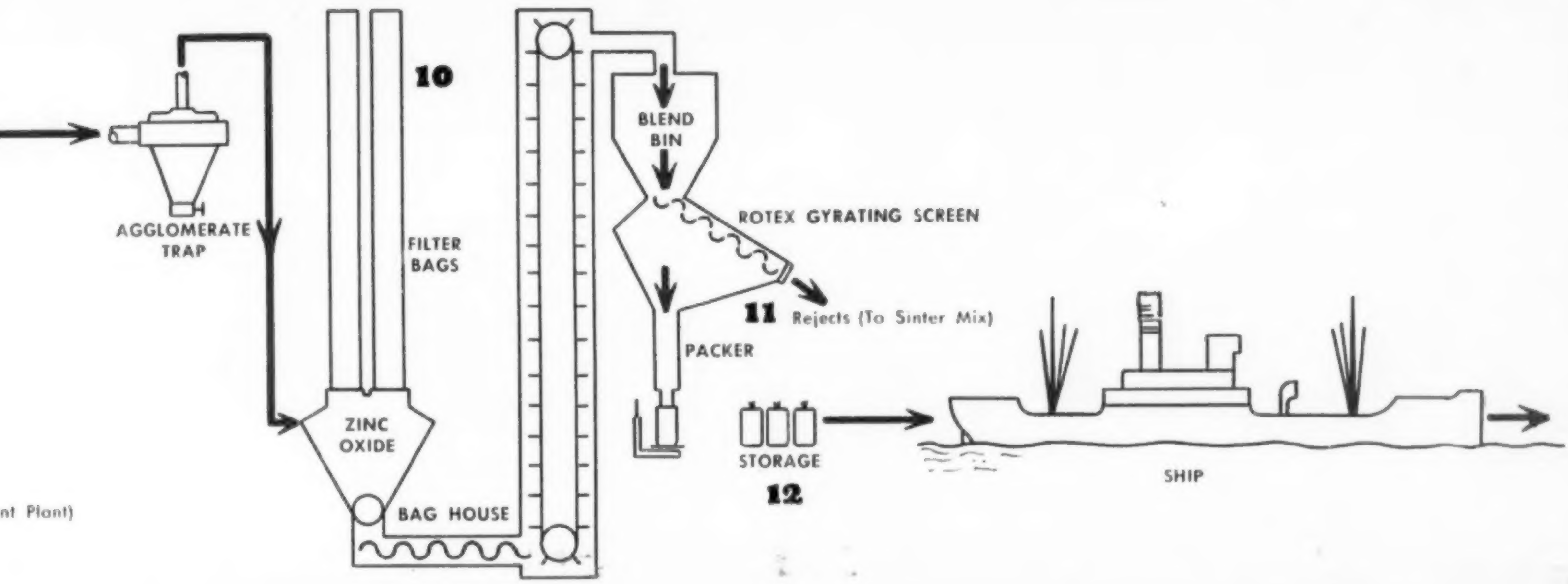




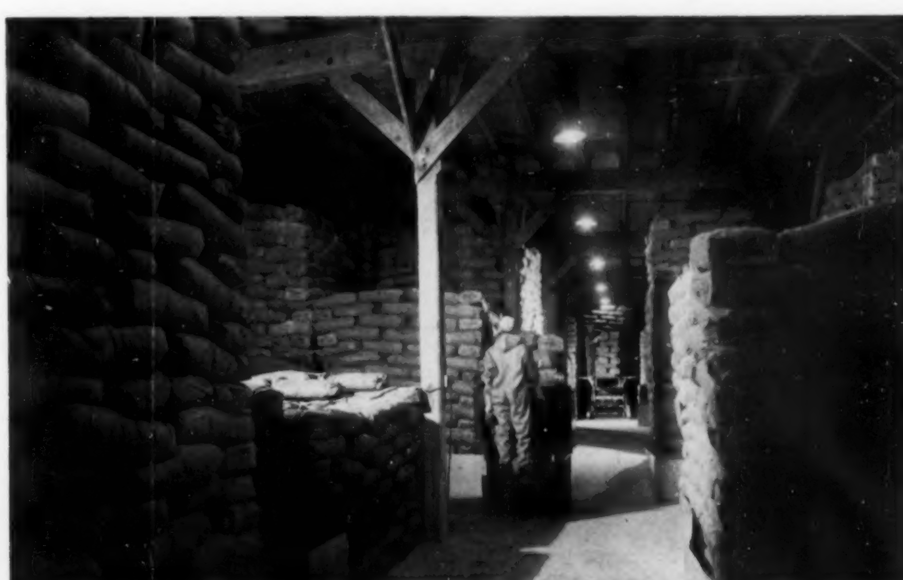
11 Mechanical zinc oxide packers. The
packed, whence it is sent to storage or ship

ols for electrical imput to furnaces at the Joseph-
Co.

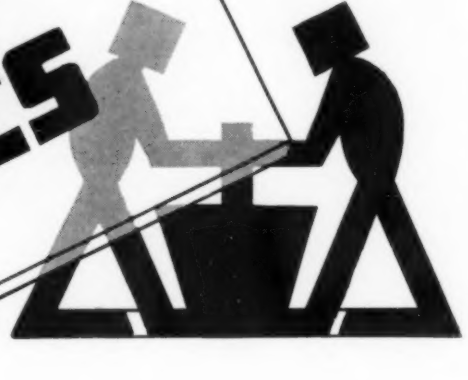
10 The bag room where zinc oxide fumes are received from the furnace. The particles cling loosely together and are caught in the meshes of cloth bags



packers. The oxide is collected, graded, screened, and
storage or shipped direct to the customer



12 Section of the zinc oxide storage warehouse showing mechanical transportation and stacking of the zinc oxide packages at the Josephtown plant of the company



Technical, Industrial, Personal

ANTI-TRUST SUITS TIE IN WITH PRODUCTION BOTTLENECKS

Criminal indictment under the anti-trust laws is being developed in the New Deal wing of the Administration as another means of "policing" alleged bottlenecks in production capacities and prices of vital commodities. Indictments aimed at what Thurman Arnold calls a German-American patent and production pool in magnesium is the case in point.

These indictments naming Aluminum Co. of America, I. G. Farben Industrie of Germany, Dow Chemical Co., American Magnesium Corp., Magnesium Development Co., and the General Aniline & Film Co., and a number of individual officers, charge that German and American patents were pooled in 1931, that American production was limited, that fabricators were made dependent upon a single source of supply and that magnesium prices were maintained artificially high.

Arnold's purpose in this line of attack is to break up alleged international agreements between American and Axis concerns to end what he charges restricts this country's production and creates domestic monopolies of vital materials. For magnesium his goal is to open the production and fabricating fields to others desiring to go into the business. If his suit doesn't do the trick, Arnold would like to promote some sort of government patent confiscation under dormant laws left over from the last war.

Arnold openly has decided to seek only criminal indictments instead of civil action, contending that this speeds up conclusion of his cases. Arnold did clear the magnesium defendants of any deliberate "un-American" tieup with the Nazis. The alleged price-fixing and production limitation he called simply American industry's idea of smart business tactics which Hitler took advantage of.

MUNITIONS PLANT PROGRAM MAKES FURTHER PROGRESS

The government's munitions plant program has reached the lull between the first section and the second. Bulk of the projects in the initial program to provide production facilities for a 2,000,000-man army are underway; plans for the second chain of plants, which will be available as production facilities for a 4,000,000-man army or to aid Britain, are still in the lump sum figure stage—and even the lump sum figure at present is largely a guess.

Biggest development during January was award of a \$48,000,000 contract for construction and equipment of the smokeless powder factory at Childersburg, Ala., which is to be du Pont built and operated. One-third of the cost of this plant will be paid by the Navy which will get one-third of the output. This is the first plant scheduled on this sharing basis.

Construction contracts also were announced during January for two of the bag loading plants to be operated in conjunction with the smokeless factories. Winston Brothers Co., C. F. Haglin and Sons, Inc., and Missouri Valley Bridge & Iron Co. share a \$15,227,080 contract to build the plant at Charlestown, Ind., which Goodyear Engineering Corp. will equip and operate. Mason & Hanger will build a \$9,376,000 bag loading plant to be Hercules Powder operated at Pulaski, Va., in conjunction with the Radford powder factory.

DIAMOND ALKALI WILL BUILD SILICATE PLANT IN TEXAS

The Diamond Alkali Co. of Texas was incorporated recently to manufacture and distribute alkalies and other chemicals in Texas. The new company has taken over the Gulf Coast Chemical Co., and will continue to operate this as a division with the main office in Houston, Texas as well as branch offices in Dallas and other cities.

The Diamond Alkali Co. of Texas has purchased a tract of land in Dallas at South Lamar and Lenway Streets and in the near future will start construction of a new plant to manufacture silicate of soda and silicate products. A contract for the erection of the new plant has been placed with the Rust Engineering Co., Pittsburgh. It is expected that construction will be completed and plant operations commenced in August.

CHEMICAL ENGINEERS NEEDED FOR NATIONAL DEFENSE WORK

Qualified persons are urged by the Civil Service Commission to file applications for the position of chemical engineer. There are various grades of chemical engineer positions open, with salaries ranging from \$2,600 to \$5,600 a year. Engineers with experience in strategic mineral research are especially needed by the Bureau of Mines. The Regional Research Laboratories of the need of persons experienced in industrial utilization of surplus agricultural products. Separate employment lists will be established for positions in various specialized branches of chemical engineering such as fuels, foods, petroleum production, and plastics.

Applicants must have completed a four-year college course with major study in engineering. Professional experience in chemical engineering is also required. Appointees will perform engineering work in such fields as pilot plant investigation, design and installation of equipment, and correlation of research data in the specialized branches of chemical engineering in which the appointments are made.

SALE OF MUSCLE SHOALS NITRATE PLANT PROPOSED

Legislation designed to give the Tennessee Valley Authority to sell or lease Nitrate Plant No. 1 at Muscle Shoals for private industrial use has been introduced by Representative John J. Sparkman, Alabama Democrat. The bill would permit TVA to sell or lease, or transfer to other government agencies any of its property except permanent dams, hydraulic power plants, fertilizer plants or munitions plants. It has been reported that a leading chemical company has expressed interest in converting the now idle Nitrate Plant No. 1 into a modern chemical industrial plant.

AMERICAN CERAMIC SOCIETY WILL MEET IN BALTIMORE

The American Ceramic Society, Inc., will hold its forty-third annual meeting at the Lord Baltimore Hotel, Baltimore, March 20–April 5. Carl G. Hilgenberg is honorary chairman of the local executive committee with Walter A. Weldon chairman. The Board of Trustees will meet on March 29 and also on the following day. Papers covering every phase of ceramic technology have been prepared for delivery at the technical sessions. On April 3 and April 4, visits will be made to plants in the vicinity, to museums, Annapolis, and Washington. On the evening of April 1, there will be a moonlight cruise on the Chesapeake.

TEXAS GULF SULPHUR SPONSORS RESEARCH PROGRAM

The Texas Gulf Sulphur Co. has inaugurated a long range program of research at Boyce Thompson Institute, Yonkers, N. Y. The initial investigation will be devoted to a study of the fundamentals in the use of sulphur as an insecticide and fungicide. It will be under the direction of Dr. Frank Wilcoxon. It is hoped that these researches will clarify existing knowledge regarding fungicidal or insecticidal sulphur, establish specific physico-chemical data, particularly vapor pressure data of sulphur dusts and determine the influence of particle size, etc., on the efficacy of sulphur in controlling insects and plant diseases.

News from Washington

WASHINGTON NEWS BUREAU, McGRAW-HILL PUBLISHING CO.

DEFENSE MUST be speeded. Therefore, anything which even slightly slows defense plans must be sacrificed. This is the new attitude of Washington. Furthermore, the defense program now contemplates the development of capacity for all necessary materials of war to the point sufficient for a four-million man army.

The enlarged program does not assume either that the United States will soon be in a shooting war, or that we shall have four million men under arms. It does assume that we are the arsenal for all anti-Axis belligerents. And the second half of the capacity is assumed to be necessary to care for our friends' material needs in the event we should happen to get into war in addition to being their source of supply.

Accelerating international goods movement is an essential part of this program. The building of more ships is, therefore, an integral part of the speed up. This is necessary on the assumption that the United States must carry all the goods which constantly reduced British tonnage cannot carry. There is no present Washington expectation of convoys by the United States Navy or the sending of the United States flag into belligerent waters. But we will take over all the trade routes which do not involve prospective danger to ships flying our flag, so that Britain may concentrate her merchant marine on direct supply routes in the danger zones.

The New O.P.M.

Defense organization now is under the Office of Production Management headed up by Knudsen and Hillman, supported by Secretaries Knox and Stimson. And there is plenty of authority now to do many things which the old Defense Advisory Commission could not have even seriously urged, much less ordered. The three major divisions of O.P.M. deal with purchases (Donald M. Nelson), production (John D. Biggers), and priorities (E. R. Stettinius, Jr.). Chemical industry is most concerned with the production division which includes three major sections. One of these, under W. Averell Harriman, cares for matters of industrial materials supply. Chemicals and many of the other products of chemical process industry are "industrial materials" within the meaning of the present organization. The three groups under Harriman deal with agriculture and forest products (directed by R. R. Deupree of Procter and Gamble), with metals and minerals (directed by George M. Moffett of Corn Products Refining Co.), and chemicals (directed by E. R. Weidlein of Mellon Institute). The chemical unit formerly under and associated with Dr. Weidlein's Defense Advisory Commission group is now wholly here, as the chemical group of O.P.M.

It will be noted that the new policy places executives in charge of commodity groups which are not related to the normal business connections of these men. This is a deliberate action both to reduce the chance of prejudice and to protect the individuals from charges of bias. Subordinates particularly skilled in various commodities will continue in an advisory or junior administrative relationship. But major policy decisions will not be made by men from industry normally active in the same fields as they are asked to handle in Washington.

Goods Speed Up

Priorities will be used directly or indirectly when necessary. As yet most of the requisite speed is being obtained with voluntary methods in which contractors and subcontractors merely meet the necessary "requested" dates. Some rationing of certain goods may come before long. For example, there is general talk that the quantity of steel which the automobile industry can have may be limited some time this summer or early fall. Other like action may come sooner on other commodities when a pinch of short supply is experienced.

Export controls were extended during January to additional commodities, including brass, bronze, copper, zinc, nickel, potash, and others. But a general program of free export to Canada is established, in effect, by "general" licenses. Full reporting is required, but restrictions do not govern except on a very few goods, particularly arms, ammunition, and implements of war.

Where main contractors can get faster action by subcontracting part of their manufacturing job, they are being urged to do so. As yet, there is no compulsion. That may come later if the voluntary technique is not adequate to get wanted results.

Strategic Stock Piles

The R.F.C. has been the major agency financing the building of military reserves of strategic and critical materials. In mid-January the status of that program was described in a letter by Administrator Jesse Jones to the President. The following situation was revealed:

Rubber Reserve Co. has arranged to purchase 430,000 tons of crude rubber at a cost of $190,000,000, of which 52,000 tons are in hand and 20,000 more tons in transit. About 16,000 tons merely await cargo space at the point of shipment. The balance is expected during 1941. It will be noted that the average purchase price is approximately twenty cents a pound. The government purchasing is being arranged so that it does not interfere with normal industry purchases nor advance the price. Incidentally, Commodity Credit Corp. is acquiring by its cotton exchange deal, 95,000 tons additional of raw rubber, most of which is in hand.

Metals Reserve Co. is purchasing antimony, chrome ore, managanese ore, tungsten trioxide, tin, copper, graphite, and other minor mineral and metal commodities to the extent of about $377,000,000.

Defense Supplies Corp. is purchasing $50,000,000 worth of high-test aviation gasoline and has contracted for 300,000 tons of Chilean nitrate of soda, the latter at an average price of $18 per ton. Only one-third of the nitrate can be brought to the United States promptly because of lack of ship space. A quarter of a billion pounds of wool have also been purchased from Australia.

Other spending or commitments by R.F.C. include Defense Plant Corp. aid in building industrial works, certain defense loans, and other aids. Total commitment aggregated $1,100 million in mid-January. All of this spending and aid program is, of course, in addition to direct Army and Navy purchasing of goods or contracts for plants and facilities.

Price Problems

Industrial price Commissioner Leon Henderson has been very successful in controlling certain goods prices, notably copper. But other units of the government seem disposed to criticize the rigid price controls sought with respect to other commodities such as zinc scrap, iron and steel scrap, and iridium.

These more conservative government men point out that present government effort to hold scrap prices down prevents normal expansion and new effort in the scrap industries, which might otherwise bring out several million tons of additional iron and steel, if the scrap price were perhaps $5 to $8 per ton higher.

In the case of iridium it is pointed out that the unquestioned big jump in price was an increase in the charge by Russia for imported iridium raw material. The implied criticism of American refiners is, these officials believe, wholly unjustified. They point out that the United States must officially deal with these foreign governments if they expect to keep the price of such a rare metal anywhere near normal levels when huge increase in consumption is in prospect. American refiners are, it appears unable alone to exercise the desired control.

New Magnesium Contract

The newspaper announcement, not authorized by the government, that a huge new magnesium plant was to be built in California aroused much speculation and considerable comment. It is

authoritatively reported that Henry Kaiser and some of his western construction associates propose to erect facilities in California for making 12,000 tons per year of magnesium. Their plan is reported to be the erection of a magnesia works near Palo Alto and the development of the old Hansgirg process for converting the oxide to metal.

It is reliably reported that a large R.F.C. loan is sought. But no announcement of any contract between these priducers and the government was disclosed up to the end of January. Washington infers, therefore, that the company intends to follow the sixty-month amortization program for its new construction and to take its chances on selling the magnesium made to the aircraft industry.

There is no question in Washington but that additional magnesium capacity of this order of magnitude is desired by the Government. There is, however, great speculation as to whether the process proposed for use in California is the most economical. It is expected, therefore, that some other proposals or potential proposals will be considered by the Government before the whole matter is finally settled. Final decisions as to what further aid or encouragement the Government will give these matters is likely to be determined by the new division of metals and minerals of O.P.M. under George M. Moffett. That office is, however, presumably still guided by the frequently stated principle that the Government prefers not to buy such a raw material as this. It prefers that the builders of aircrait and other users of magnesium on government contracts be the purchasers. The only concern is that there shall be adequate light metal available, so that there need be no delay in desired plane or other equipment construction.

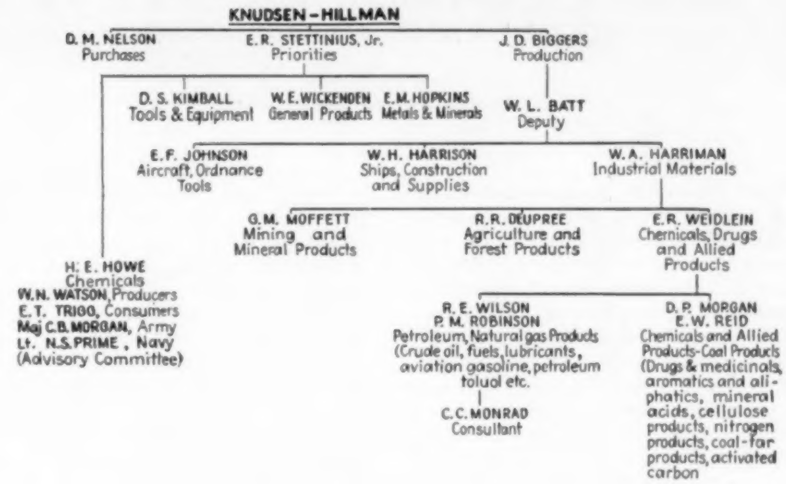
The New Congress

The first job for Congress is, of course, authorization of a new munitions program by which America can more actively cooperate with Britain. Then will come the financial legislation, including a new debt limit, greatly increased appropriations, and some new tax plan partly to offset the stupendous deficit which a minimum of $17.5 billion spending will involve.

Some other special items of legislation will be carried on in parallel. But these will be principally those bills of definite military significance. One of that group is the bill proposing that the Bureau of Mines administer a license program for all makers, marketers, and users of explosives. The revised bill for that purpose is, according to industry spokesmen, a much more workable one because it enables administrative discretion to determine what commodities, or quantities, and what technical rules of handling are to be supervised.

It seems unlikely that most other legislative matters will have any im-

Office of Production Management



portant attention until late Spring; but some of the spare time of the minor committees may be so used.

Chemical Warfare Service

Chemical Warfare Service's gas defensive production program expanded during January from the two activated carbon contracts previously identified to a nine-plant setup. A total of $10,000,000 is involved for new plant construction and added facilities for gas mask charcoal and other chemicals used in gas defensive appliances.

In addition to the contracts for carbon produced from a domestic sawdust base previously announced for National Carbon Co. and Barnebey-Cheney Engineering Co., similar contracts have been given the Atlas Carbon and Clay Co., Glendale, Cal., and Carlisle Lumber Co., Seattle, Wash. New plants for making other needed chemicals will be erected by Monsanto Chemical Co., at its present plant site in East St. Louis; Dow Chemical Co., at Midland, Mich., and E. I. DuPont de Nemours & Co., at Niagara Falls. These plants will be government-owned and privately operated on a fixed fee basis. Cost of these plants will not be announced, nor will the exact products to be made be identified. Two other contracts which do not require additional plants were awarded Carbide and Carbon Chemical Corp. of New York, and Dewey & Almy Chemical Co., Cambridge, Mass., to complete the program.

Farming Out Contracts

The British formula of "bits and pieces" is being incorporated in America's speedup defense drive under the designation of "farming out." So far the plan is being applied only to machine tools and like equipment and to big mechanical assembly jobs, such as airplanes.

The "farming out" drive is headed up by two Milwaukee brothers, Joseph L. and Francis Trecker, who built a thriving business on the principle of sub-contracting as much of their parts work as they could find small idle plants to take. Both Treckers have been called in by the War Department as $1-a-year men.

While the program at present is aimed at helping break the log-jam in the machine tool and airplane parts production bottlenecks, "farming-out" is considered in Washington to have practical application to many other fields. A manufacturer of mixed chemicals might, for instance, be able to "farm out" production of part of the original chemicals, thus conserving more of his own plant for the mixing operation. At any rate, sub-contracting is becoming the slogan for speeding up defense.

Economic Warfare Program

Discussion in Washington for applying a "squeeze" to Axis powers by buying Latin American minerals not because the U. S. needs them so much as to keep them away from Germany and Japan is rapidly broadening into plants for an over-all program of economic warfare. In early February, indications were that the groundwork is being laid for this as the next phase of the Administration's aid-to democracies program.

Essentially, the program involves extension of the British blockade by cutting off supplies at the source. Clearest idea of how this is being planned comes from Hugh Dalton, Minister of Economic Wartare in London, who has told Commons he expects the U. S. to bar its ports to vessels carrying commodities which appear likely to be intended for ultimate Axis delivery and to freeze German assets in this country. On this side of the Atlantic, technical freezing of credits of all nations to avoid obvious "discrimination" is considered more likely. President Roosevelt has admitted such a move is under consideration.

Nucleus of this "economic warfare" program, when it comes, will be the Export Control Administrator's Office which already is planning expansion, and seems likely to get considerable increase in its ranking authority.

GERMANY IS DECENTRALIZING PRODUCTION OF WAR GOODS TO LIMIT AIR-RAID LOSSES

From Our German Correspondent

DECENTRALIZING production and placing war orders uniformly over the Reich to lessen the risk of air raid damage brings up a number of questions of interest to the German businessman. At the outbreak of the war, military orders were concentrated in plants usually located in the interior, but during the past few years new war-important industries have been removed from frontier regions. With the cessation last spring of "continental" land operations and the continuance of RAF raids, orders are now being given to many smaller plants all over Germany. Another reason for placing orders with small and medium-sized firms is that the government wants to keep up their capacity for later peacetime operations.

The war is thus bringing the Reich's economy into a new phase. When the Nazis first came into power, they favored the small operator, at least in the consumer-goods industries, and openly proclaimed the desire to break up large distributing organizations, especially in the department store and textile industries. Later, when various measures were introduced which set up restrictions and red tape in export, foreign currency, and tax fields, smaller producers could no longer maintain top heavy administrative costs and either had to combine or go out of business. Raw material shortages and the "autarkie" drive to produce synthetics automatically favored the larger units since they had the research and financial organization capable of taking over new less-profitable production. The Conversion Law of 1934 and the New Company Law of 1937 reduced the number of smaller companies still further, since thereunder no new corporations could be capitalized for less than 500,000 RM, and existing companies with a capital of less than 100,000 RM had to be converted into partnerships or to individually-owned businesses or be liquidated by the end of 1940.

One way the smaller companies have been able to stay in business has been through the formation of production "rings," as in Wuerttemberg in southern Germany. The mother company of the L'Orange Ring, as described recently in the Rundschau Deutscher Technik, takes over the risks of maintaining stocks, exports, sales, research, and determination of products to be made, while the small member firms take the risks of production only but are otherwise left a considerable degree of independence. The "ring," established in the depression of 1932, is probably the prototype for the present organizations sub-letting contracts for government orders.

That labor shortages rather than raw material shortages are causing industrial "bottlenecks" in Germany is evident from press reports as well as from classified advertisements for skilled labor in technical journals. War prisoners and civilian workers from occupied territories have helped fill the gaps of unskilled labor. At the close of the harvest season many skilled workers among war prisoners were assigned to work in the chemical and metal industries. A further "combing out" of skilled laborers in plants where they are not absolutely needed and transfer of between 500,000 and 800,000 workers to other parts of the Reich in recent months also reflects the trend toward decentralization of war industries, as mentioned above.

With increased emphasis on airplane production and the substitution of lighter for heavier and imported metals, the Reich is pushing aluminum production at top speed. It now claims to have outdistanced even the United States in this item, although actual production figures are not published. The aluminum industry in the Reich has long been virtually stated-owned, leading firms being the Vereinigte Aluminumwerke, Lautawerk, Aluminiumindustrie A. G., Neuhausen, Metallgesellschaft A. G., Frankfurt, and the Oesterreichische Kraftwerke, the latter an Austrian power company. France and Yugoslavia supply considerable quantities of the necessary raw material, bauxite. Norway, an important aluminum producer because of its cheap water power, has developed a new process in trying to make itself independent of bauxite imports. "Norsk Hydro," in which I. G. has an interest, is treating labrador, a calcium- and sodium-containing feldspar, abundantly available in Norway, with nitric acid to produce aluminum oxide which is then reduced to pure aluminum.

The increased processing of aluminum yields a greater amount of aluminum scrap in the form of shavings and filings, which are being regenerated in the Reich. To apply the latest recovery process described in the Berlin publication "Aluminium," new equipment has been designed: a crusher to break up the shavings, a centrifuge and drying drum to remove oil and water, a magnet to separate iron particles, and charging equipment to insert the scrap into the ovens. Since shavings offer a thousandfold larger surface than blocks and are in danger of burning up in the furnaces, salt, which is later recovered and regenerated, is inserted with the aluminum furnace charge.

In addition to being used for cables to replace copper, aluminum is also being used on brake linings for railway cars in the place of imported asbestos. The new linings are made of "fiber" of aluminum "wool" 0.03 mm. thick, each being covered with a synthetic rubber coating. The new lining which has been tested over a five year period in actual use, is claimed to be waterproof and just as efficient as asbestos linings.

Synthetic Buna rubber is also finding increased use in railway car, automobile, and airplane construction as an insulating material against vibration and noises. The non-swelling Perbunan type of Buna has been successfully used on street cars as bushings for wheels and as springs and shock absorbers and also for couplings on motors. Since it can be attached to metals, plastics, wood and glass, and is noncorrosive and resistant to oils and fats, Perbunan has found many uses in industry. Aside from use in automobile tire manufacture—the latest product is a soft solid rubber tire—Perbunan rubber is being substituted for ink rollers on the printing presses, in replacing leather rollers in the textile industry, for hoses in oil refineries and gasoline stations, and as a covering for wiring and a lining for containers in the chemical industry. According to recent reports, Buna is also now being used almost exclusively for shoe soles both on new shoes and in repair shops.

Although the Reich has been obtaining large supplies of cork from Spain, engineers are constantly at work to achieve satisfactory substitutes for imported cork. This is especially true in the field of large scale refrigeration and wall insulating materials. Among the various substances tested for this purpose are pressed peat boards, plates of slag and glass wool, pine bark, hemp scraps, porous concrete, etc. Because of either cost, weight, susceptibility to decomposition, or moisture absorption, none of the materials so far developed is entirely satisfactory.

CHLORINE INSTITUTE ELECTS OFFICERS AND DIRECTORS

At the annual meeting of the Chlorine Institute, Inc., held at The Chemists' Club, New York, on Jan. 22, the following directors were elected for two years: N. E. Bartlett, Pennsylvania Salt Mfg. Co.; Thomas Coyle, R. & H. Chemicals Department, E. I. duPont de Nemours & Co.; John A. Kienle, The Mathieson Alkali Works; Louis Neuberg, Westvaco Chlorine Products Co.; and Eli Winkler, Columbia Chemical Division, Pittsburgh Plate Glass Co. The hold-over directors are: R. W. Hooker, Hooker Electrochemical Co.; S. W. Jacobs, Niagara Alkali Co.; and E. C. Speiden, Isco Chemical Division, Innis, Speiden & Co.

At the directors meeting which followed the annual meeting officers for the current year were elected as follows: S. W. Jacobs, president, E. C. Speiden, vice-president, and Robert T. Baldwin, secretary and treasurer.

COMPANIES ELIGIBLE TO AMORTIZE PLANT EXPANSIONS

The first list of companies certified to the Internal Revenue Collector as eligible to amortize emergency plant expansion over five years on tax reports was issued late in January. It included 67 firms with expansion valued at $120,188,000, mostly in the machine tool and airplane fields but including also a number of mining, industrial and electrical equipment firms.

In addition to the 67 certificates granted, the War and Navy Departments have dozens of other applications pending as a result of the initial rush for accelerated amortization of defense plant construction. It is practically too late now to file applications for work started last year, but new facilities currently being planned for defense orders are eligible whenever work starts.

Applications from prime contractors must show that the added facilities are being built to turn out defense orders and that the facilities would not be required for normal business. Sub-contractors seeking 60-month amortization of expansion must list increased demands for their products and show how the products of these customers fit in with defense needs. Sub-contractors, too, must show that the added facilities would not be needed for normal orders.

Included among the list of companies granted 60-month amortization certificates are: American Smelting & Refining Co., zinc smelting facilities, $400,000; Bethlehem Steel Co., for coke, pig iron and steel ingots, $20,390,000; American Gas Accumulator Co., for flood lights, $150,000; Dewey & Almy Chemical Co., soda lime, $27,000; Hanna Furnace Corp., pig iron, $1,250,000; Humble Oil & Refining Co., toluene, $1,097,000; Johnson & Johnson, surgical cotton and gauze, $350,000; Nevada-Massachusetts Co., tungsten products, $400,000; Northwest Magnesite Co., magnesite, $315,000; Permanente Corp., magnesium oxide and metallic magnesium, $6,500,000; Tennessee Copper Co., sulphuric acid, $1,1000,000; Westinghouse Electric and Manufacturing Co., marine propulsion machinery, $5,670,000.

CHEMICALS AND DRUGS INCLUDED IN RED CROSS SHIPMENT

First small officially-permitted "leak" in the British blockade of Europe permitted shipment by the Red Cross of American Government and donated food, clothing and drugs and vitamin concentrates to unoccupied France and to Spain late in January. The British Ministry of Economic Warfare granted permission for the $1,000,000 shipload of supplies to go through at the request of the American Government.

To France the boat carried 500 tons of powdered milk, 250 tons of evaporated and condensed milk, $100,000 worth of such drugs as insulin, quinine, aspirin, iodine, camphor, bicarbonate of soda, argyrol, sulphanyalmide and sulphapiridine, digitaline as well as vitamin concentrate tablets, plus 25 tons of children's clothing produced by Red Cross women volunteers. To Spain the ship carried 4500 tons of whole wheat flour, 250 tons of powdered whole milk, 250 tons of evaporated and condensed milk.

NEW CHEMICAL ENGINEERING BUILDING FOR CORNELL

The gift to Cornell University of a new building for the School of Chemical Engineering, to be erected at a cost of $700,000, was announced by President Edmund E. Day today. The donor is Franklin W. Olin of Alton, Ill., who for many years has been president of the Western Cartridge Co. and affiliated concerns.

Mr. Olin presented the building as a memorial to his son, Franklin W. Olin, Jr., who received his M. E. degree from Cornell in 1912 and died in 1921. Construction will begin immediately, on a schedule calling for completion in October of this year.

President Day characterized the gift as "a magnificent contribution toward the realization of a broad program for development of engineering education at Cornell, which envisions an increasingly important role for the engineer in our national economy. Olin Hall of Chemical Engineering," he said, "will be an integral unit of our general plan to give the College of Engineering the resources it needs to project its tradition of leadership into the future." The plan contemplates similar buildings for the other three schools of civil, mechanical, and electrical engineering, with a materials and metallurgy laboratory. These buildings will form a new quadrangle on the southern portion of the main campus.

POSITIONS OPEN FOR MEN WITH METALLURGICAL TRAINING

Because of difficulty in filling positions in the Bureau of Mines in connection with the defense program for developing strategic metals, federal civil service rolls have been opened for applications for positions of metallurgist and metallurgical engineer, various grades, with salaries ranging from $5600 to $3200 a year. Applications will be received until December 31, 1941.

Applicants will not get a written test. They will be rated on educational training and experience. A 4-year college course with major study in chemistry, geology, mining, physics, engineering or metallurgy is needed plus responsible experience. For associate grade, appropriate graduate study may be substituted for experience; for other grades partial substitutions may be made. A 60-year age limit is in effect. Further details are available from the Civil Service Commission in Washington.

WILLIAM CAMPBELL FELLOWSHIPS AT COLUMBIA

Through the bequest of the late William Campbell, for many years Howe Professor of Metallurgy at Columbia University, two fellowships have been established. They are awarded primarily for graduate study and research in the field of metallurgy.

The stipend of each Campbell Fellowship is fixed at the time of award by recommendation of the Campbell Fellowship Committee and will normally be an amount sufficient to meet the necessary living expenses of the incumbent of the fellowship.

Applications accompanied by certified transcripts of academic records, statements of proposed research projects and proposed fields of graduate studies should be filed with the Secretary of the University before March 1, 1941. Application blanks and announcements will be forwarded to interested persons by the Secretary of the University on request.

NEW ELECTRIC FURNACE ADDED TO MONSANTO PLANT

By adding new electric furnace facilities for the production of elemental phosphorus at its plant at Monsanto, Tenn., Monsanto Chemical Co. now has the largest elemental phosphorus plant in the world.

A fourth electric furnace, substantially increasing productive capacity of the plant, was placed in operation on Jan. 7, at ceremonies attended by Edgar M. Queeny, president, and Charles Belknap, executive vice president. Felix N. Williams is manager of the plant.

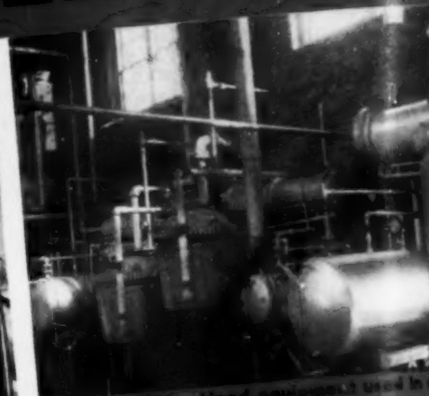
The new electric furnace capacity is expansion foreseen at the time the plant was erected in 1937 and is part of a master plan of development by the Phosphate Division, which has plants also at Anniston, Ala; Carondelet, Mo.; and a new phosphate plant under construction at Trenton, Mich.

SHELL OPERATES FIRST PIPELINE FOR BOSTON TERRITORY

Operation of the first pipeline to serve the Boston market was started on Jan. 23 by the Shell Oil Co. The new line, which will transport only finished petroluem products, links the 45,000,000 gallon storage capacity of Shell's Fall River ocean terminal with a newly erected bulk plant at Waltham, located on the outskirts of Boston.

Operating on a 24 hour basis, the pipeline is capable of supplying in excess of 420,000 gallons per day, and is regarded as a highly important part of the New England defense system. In the event of a national emergency, a large portion of Boston's petroleum requirements can be currently supplied by the line, relieving rail, water and highway transportation facilities for the movement of other supplies into and out of the city.

YOU CAN'T "BACK-ORDER" HEALT



Glass-Lined equipment used in m... Sulfanilamide.

Glass-Lined alcohol and solvent rec...

Glass-Lined Storage Tanks for recovered...

Glass-Lined Storage for...

All Glass-Lined...

WITH many foreign sources of drugs and pharmaceuticals out of the picture . . . with orders doubled, tripled and even quadrupled . . . the pharmaceutical industry faces an overburdening demand for "all-out" production.

Because there can be no let-down in quality, this unprecedented expansion program demands the utmost cooperation of the Pfaudler Company—cooperation we are glad to give.

Today, druggists' shelves remain filled . . . with products as pure and as free from dissolved metals and other impurities as Pfaudler Glass-Lined Steel Equipment and American manufacturing standards can make them.

In this troubled year, as in the many years past, Pfaudler is proud of the part Glass-Lined Equipment is playing in safeguarding the health of the nation. As the only material of equipment construction totally resistant to all acids (except HF), Pfaudler Glass-Lined Steel meets the most exacting purity standards of America's most exacting industries.

THE PFAUDLER CO., Executive Offices: Rochester, N. Y. Factories: Rochester, N. Y. and Elyria, O. Branch Offices: New York, Boston, Philadelphia, Chicago and Cincinnati. Pfaudler Sales Co., San Francisco and Los Angeles. Representatives in principal cities.

PFAUDLER

LINED AND ALLOY EQUIPMENT

PERSONALITIES

Daniel S. Dinsmoor

Edwin L. Dennis

✦ DANIEL S. DINSMOOR, manager of the Monsanto Chemical Co. plant at Monsanto, Ill., has been promoted to assistant general manager of the Organic Chemicals Division of the company. His headquarters will be in St. Louis.

✦ ALEXANDER W. LIMONT, JR., is now in the research and development department at the Frankford plant near Philadelphia of The Barrett Co. He is making his home at Wynnewood, Pa.

✦ EDWARD KIHN, who received his Ph.D. degree from the University of London, is now connected with the engineering and construction division of the Koppers Co., Pittsburgh, Pa.

✦ MELVIN E. CLARK joined the technical staff of Michigan Alkali Co., New York, on February 1, to conduct market research activities. Since 1937 Mr. Clark has been associated with McGraw-Hill Publishing Co. as assistant editor of *Chem. & Met.*

✦ THOMAS B. COLLINS has been made Washington, D. C., representative of the Porcelain Enamel Institute which has recently opened an office in that city.

✦ WILLIAM C. YATES, since 1937 manager of the control and renewal parts division of General Electric's industrial department, has been appointed an assistant manager of the industrial department, it was announced recently by J. E. N. Hume, manager of the department and commercial vice president of the company. Mr. Yates will continue to have charge of the industrial control and renewal parts division.

✦ EDWIN L. DENNIS, chief combustion engineer, of Coppus Engineering Corp., Worcester, Mass., since 1939, has been appointed to the faculty of Louisiana State University, Baton Rouge. He retains his connection with Coppus organization.

✦ RICHARD M. HITCHENS has been promoted from group leader in the Organic Chemicals Division of the Research Department, Monsanto Chemical Co., to assistant research director according to a recent announcement by Dr. L. P. Kyrides. Dr. Hitchens succeeds Dr. Russell L. Jenkins who recently was promoted to director of research for the Phosphate Division.

✦ J. R. B. ELLIS is studying in the law school of Stanford University in preparation for future work in patent law in connection with chemical engineering.

✦ GEORGE N. JEPPSON has been elected president of the Norton Co. to succeed Aldus C. Higgins who resigned to become chairman of the board, a position vacant since the death last year of Charles L. Allen. Mr. Jeppson has been vice president and treasurer. He joined the Norton Co. 49 years ago; after being assistant superintendent and works manager, he was chosen a director in 1906. In 1919 he was made secretary and in 1923 he became treasurer. He has been a vice president for several years.

✦ R. A. ASBURY, who has been manager of the American Cyanamid & Chemicals Corp.'s Joliet, Ill., plant during the last ten years, has been given increased responsibilities in the corporation's activities. Mr. Asbury will move to Chattanooga, Tenn., where he will become manager of the corporation's plant at that point and in addition will take over the supervision of the corporation's mining interests in Georgia and other southern states. He will also continue in a supervisory capacity over mining operations in Arkansas.

✦ LYLE K. MAYNE will become manager of the Joliet, Ill., plant of the American Cyanamid & Chemical Corp. For some years he has been manager of the corporation's plant at Linden, N. J.

✦ THOMAS B. MCCABE has been elected a director of Air Reduction Co. Mr. McCabe is president of the Scott Paper Co. of Chester, Pa., a director of the Brunswick Pulp & Paper Co. of Brunswick, Ga., chairman of the board of the Federal Reserve Bank of Philadelphia, and a member of the advisory commission to the Council of National Defense.

✦ RALPH T. GOODWIN, formerly manager of fuel oil sales for Shell Oil Co., has been appointed manager of Shell's aviation department. Dr. Goodwin's appointment is made in conjunction with Shell's enlargement of its aviation activities in the growing national defense needs. Dr. Goodwin, prominent in the fuel oil technological and the marketing field, comes to his new position with equally high qualifications. During World War I he was in the chemical division of the U. S. Bureau of Aircraft Production. While in the chemical section of the engineering division of the U. S. Army aviation experimental work at Dayton, Ohio, he had charge of chemical research and inspection of materials going into aircraft production and products consumed in airplane operations. Later he was on the technical staff of the U. S. Army Balloon School at Fort Omaha, Nebr. He joined Shell in 1932 as manager of the company's fuel oil department in St. Louis.

✦ H. N. MIDDLETON of B. F. Sturtevant Co.'s Camden branch, has been relieved of sales duties and has been appointed engineering consultant for the eastern division. He will serve customers in an advisory capacity on dust and fume control and pneumatic conveying problems.

✦ A. L. MERCER, president of The Cowles Detergent Co., has announced that at a meeting of the directors, the following officers were elected: E. N. Horr, vice president and general man-

ager; C. C. Bassett, vice president and director of sales; C. C. Barrett, secretary and treasurer and C. H. Fisher, assistant secretary and assistant treasurer.

✦ WILLIAM G. KUMMRICH has been made manager of the Monsanto, Ill., plant of Monsanto Chemical Co. He has been manufacturing superintendent of that operation.

✦ SAMUEL COTTRELL, assistant manufacturing superintendent at Monsanto's Illinois plant, will be manufacturing superintendent for inorganic chemicals.

✦ ROBERT M. SANFORD, supervisor at the Monsanto, Ill., plant of Monsanto Chemical Co. will be manufacturing superintendent for the organic chemicals at that plant.

✦ PAUL TOMPKINS, assistant supervisor of the phenol department of the Monsanto Chemical Co.'s plant was promoted to the position of assistant to the plant manager.

✦ ALBERT H. COOPER is on a leave of absence as associate professor of chemical engineering from the Virginia Polytechnic Institute, Blacksburg, in order to serve as a chemical engineer in the Plants Division at Edgewood Arsenal, Edgewood, Md.

✦ O. T. BARNETT has joined the welding electrode department of Metal & Thermit Corp. in the capacity of engineer of tests. Mr. Barnett is a chemical engineering graduate of Armour Institute of Technology. All electrode test work including the manufacturing control testing at both the Jersey City and the East Chicago plants as well as research work on uses and applications of electrodes will be under his supervision.

✦ G. K. RYAN has been named manager of latex elastic yarn, cut and latex thread sales of the B. F. Goodrich Co. He joined the Diamond Rubber Co. in 1911, a year before it was merged with Goodrich, and in 1921 was transferred to production work in the mechanical division. Later he managed factory operations on the manufacture of mechanical rubber goods.

✦ H. F. VERITY, during the past two years, built and operated the first edible oil plant in Mississippi. The plant was that of the Buckeye Cotton Oil Co. at Jackson. Recently he has been transferred to the Macon plant of Procter & Gamble as superintendent. He retains the same title at the Jackson, Miss., plant.

✦ JOHN R. RYAN has been transferred to the Kenvil, N. J., explosives plant of the Hercules Powder Co. Mr. Ryan graduated from the chemical engineering department of the University of

Minnesota in June of 1940 and a short time later became associated with Hercules at the Experimental Station near Wilmington, Del.

✦GEORGE W. JOHNSTON is now associated with Ethyl Gasoline Corp. in its technical division at the Baton Rouge, La., plant.

✦LESTER G. HEUSTIS, who has been connected as chemical engineer with Arthur D. Little, Inc., Cambridge, Mass., is now employed on the engineering staff of the Cone Automatic Machine Co. of Windsor, Vt.

Russell L. Jenkins

✦RUSSELL L. JENKINS has been appointed director of research for the phosphate division of Monsanto Chemical Co., it has been announced by R. R. Cole, general manager. Dr. Jenkins has been transferred to the phosphate division laboratories in Anniston from St. Louis, where he was assistant director of research for the organic chemicals division. Dr. Jenkins began his employment in 1924 at Mellon Institute where he had a fellowship. During 1926 and 1927 he was employed as a research chemist for the du Pont Rayon Co. He then joined the Swann Chemical Co. at Anniston; in 1935 Swann was acquired by Monsanto.

✦DONALD L. MUFFAT is now with Standard Oil Co. of Indiana at Whiting. He is employed as chemical engineer in the research department.

✦MELVIN G. CRANDELL has been transferred from Detroit, Mich., and given the New England States to service for the Parker Rust-Proof Co. Mr. Crandell has been with this organization for three years. He will make his headquarters in New York City.

✦WALTER W. PLECHNER, while retaining his position of assistant director of research for the National Lead Co.'s Titanium Division, is on extended active duty as assistant A. C. of S., G-3, First Division, U. S. Army. Captain

Plechner is located at Fort Hamilton, Brooklyn, N. Y.

✦ FRED G. EICHEL, who was associated with the Old Dutch Mustard Co., Inc., is now with Givaudan-Delawanna, Inc., of Delawanna, N. J. Mr. Eichel is in research and production activities.

✦ ALEXANDER SILVERMAN, head of the department of chemistry of the University of Pittsburgh, will be presented the 1940 Pittsburgh award by the local section of the American Chemical Society, February 20, for his work in chemical education, industrial chemistry and the ceramic industries.

✦ HOWARD B. GROSSMAN, formerly associated with the Rex Refining Co., is at present employed by the Barrett Co. in the research and development department of its Frankford Plant.

✦ HENRY BAKER has been transferred to the Rochester, N. Y., office of American Blower Corp. Mr. Baker has been in the New York City office of the company.

John J. Buckley

✦ JOHN J. BUCKLEY has been appointed works manager of the Philadelphia plant of the Sharples Corp., according to the announcement of G. J. Keady, executive vice president.

✦ CARL HANER and K. H. KIEFER are now employed by the Chemical Construction Corp. in connection with some of their work in Canada. They temporarily have their headquarters in the New York office.

✦ JOHN R. SHEFFIELD was elected a director and president of Coronet Phosphate Co. on February 3. He has been associated with the company for the past year.

✦ EDWARD A. DOISY of St. Louis University of Medicine will receive the Willard Gibbs Award for this year. The medal is awarded by the Chicago Section of the American Chemical Society.

OBITUARY

✦ George T. Smith, president of the Joseph Dixon Crucible Co. since 1908, died at his home in Jersey City, N. J., on December 20 after a brief illness.

✦ Stephen Louis, assistant treasurer of Monsanto Chemical Co., died January 9 at St. Johns Hospital, St. Louis, after a prolonged illness. Mr. Louis was born February 29, 1880, in France.

✦ Harry M. Sloan, vice president, treasurer, and director of U. S. Industrial Chemicals, Inc., died December 31 in New York, after a six months illness. He was 62 years old.

✦ Paul N. Leech died January 14 in the Presbyterian Hospital at Chicago, shortly after he suffered a brain hemorrhage in his office at the American Medical Association. He was 61 years old. In 1923 Dr. Leech became director of the chemical laboratory of the American Medical Association and in 1932 became secretary of its Council on Pharmacy and Chemistry. At his death he was director of the Division of Foods, Drugs and Physical Therapy of the Association.

✦ William P. Pickhardt, senior vice president and a director of General Aniline and Film Corp., died January 22 in the Lenox Hill Hospital, New York City, after a short illness. He was 60 years of age.

✦ Walter G. Graves died Dec. 25, 1940. He was born in Rutland, Vt., in 1865 and graduated from Yale University in 1886. Mr. Graves joined Grasselli Chemical Co. after having served with Aetna Powder Co. and remained with Grasselli in various capacities until his retirement from active business in 1923.

✦ George B. Heckel, Sr., editor and publisher of the *Paint Industry Magazine*, and secretary of the Federation of Paint and Varnish Production Club, died January 19. He passed away in Philadelphia after an attack of pneumonia. He was 82 years of age.

✦ C. E. Curran, chief of Forest Products Laboratories' Pulp and Paper Division at Madison, Wis., died December 23 at a Rochester, Minn., hospital. He joined the Laboratories in 1921 after having served in the Chemical Warfare Service and in the Mead Research Co.

✦ Carleton Ellis died January 13 at the age of 64. He died of influenza in St. Francis Hospital, Miami Beach, Fla. He had recently arrived from his home in Montclair, N. J., and was on his way to his winter home in Nassau, Bahama Islands, when he was stricken ill while awaiting a plane. Mr. Ellis maintained laboratories in Montclair, N. J., and in Key West, Fla.

Chem & Met MEETINGS & CONVENTIONS

T.A.P.P.I. Meets in New York

HOTEL ROOSEVELT in New York City was the headquarters for the annual Spring meeting of the Technical Association of the Pulp & Paper Industry, held Feb. 17-20, 1941. Among the papers of special interest to chemical engineers, the following were presented:

Gypsum in Place of Salt Cake—A study of the factors involved in the use of gypsum for a part of the 300 lb. of salt cake used per ton of kraft pulp produced was made by Otto Kress and William H. Aiken of the Institute of Paper Chemistry. They found that gypsum can be reduced to calcium sulphide in the same temperature range that sodium sulphate is reduced to sodium sulphide. The rate of reduction of the sodium salt is faster than that of the gypsum, but the time for maximum reduction is the same in both cases. Conversion of calcium sulphide to sodium sulphide can be accomplished by adding a sufficient quantity of sodium carbonate to the carbon-gypsum mixture before reduction.

Green liquor prepared from the reduction of gypsum with carbon in the presence of sufficient sodium carbonate to produce a liquor containing, after causticizing, two parts of caustic soda and one part of sodium sulphide can be readily causticized. The settling rate is the same as for normal green liquor.

Gypsum should not be admixed with black liquor but should be introduced into the plant in dry form. Through the use of gypsum, white liquors of higher sulphidity can be prepared than through the use of salt cake and the sulphidity can be raised more rapidly if desirable.

As far as economics is concerned, gypsum can be substituted for salt cake when gypsum is $5 per ton and salt cake is $17.40. Calcium sulphate in the form of anhydrite at $5.50 would produce an economy if the delivered price of salt cake is over $16.50. These data are based on soda ash priced at $20 and reburned lime at $6.

Trend in Resins—Closer cooperation between paper and resin makers has led to the manufacture of "tailor-made" products to meet specific uses, according to J. F. Maguire and J. G. Rote, Jr. of Reichhold Chemicals. Heat-stable, non-toxic resins have been developed for use with paraffin wax to improve the appearance and quality of wax coatings. Improvements have been made in resins used for hot melts, and coatings can be produced having a good luster, heat-sealing properties and resistance to blocking. The temperature required for application has been reduced. Hot melt adhesives have been prepared having good flexibility, water resistance and non-toxic properties. A new method of controlling softening point of the resins has been worked out.

Urea resins have been formulated to increase the wet strength of paper and also to produce glossy, flexible, grease resistant, water resistant, and solvent resistant coatings. Melamine resins may eventually displace urea resins for certain usages due to a number of points of superiority.

Alkyd resins used as emulsions or dissolved in organic solvents have found little application in the paper field but water-soluble alkyds may prove to be of interest as a beater size for special purposes, as they are readily precipitated by acids. They can also be incorporated into casein, starch, or glue coatings to improve the toughness and adhesion.

Deinking Waste Papers—A. O. Bragg of Diamond Alkali Co. classified inks as of three types according to their deinking properties—those made from alkali-saponifiable oils, those from non-saponifiable oils and special inks made with synthetic resins and organic solvents. Oxidation reduction potential measurements reflect efficiency of ink disintegration in the deinking process. The process involves lowering the oxidation potential with alkali.

Saponifiable inks are easily removed this way, but non-saponifiable inks must be disintegrated by alkali with an adsorbent such as bentonite. Newer inks such as Vaporin and Cold-set require stronger reduction potentials obtainable by super-imposing action of a nickel catalyst on that of alkali. All factors contributory to lowering oxidation potentials during deinking, such as expelling dissolved air at high temperatures, inducing vacuum in the batch, addition of chemicals which absorb oxygen or furnish gas to dilute it (sodium carbonate) are valuable.

Status of Lignin—According to Harold Hibbert of McGill University, the older ideas of Klason that lignin is a coniferyl type (coniferyl alcohol, coniferyl aldehyde, or oxyconiferyl alcohol) of condensation polymer have received considerable confirmation in the more recent developments in the field of lignin. Principal among these are: (1) the large yield of vanillin (based on the lignin content) from spruce wood—around 25 per cent—and the still higher combined yields of vanillin and syringic aldehyde—around 40 per cent—from maplewood; (2) evidence that spruce lignin is a mixture of condensation polymers formed from simple units containing an aromatic ring having a three carbon side chain which evidence finds support in the isolation of such products as α-hydroypropiovanillone and vanilloyl methyl ketone; (3) hydrogenation of wood and of extracted lignins to give high yields of cyclohexane derivatives having a three carbon side chain, and evidently derived from the above type of unit, present either in relatively simple or more complex form.

The lignin of all soft woods appears to be identical, while that of hardwoods is differentiated only by the presence therein of large amounts of similar derivatives.

Extraction of lignin by the alcoholysis of wood (treatment of wood with an alcohol, water and a reagent such as alkali) appears to hold considerable promise of future technical application while the recent development of processes using only aqueous solutions of organic acids, such as

CALENDAR

MARCH 3-7, 1941, **American Society for Testing Materials, Mayflower Hotel, Washington, D. C.**

APRIL 7-11, 1941, **American Chemical Society, St. Louis, Mo.**

APRIL 16-19, 1941, **Electrochemical Society, annual meeting, Cleveland, Ohio.**

MAY 19-21, 1941, **American Institute of Chemical Engineers, Chicago.**

MAY 19-23, 1941, **American Petroleum Institute, mid-year meeting, Fort Worth, Texas.**

sodium xylene sulphonate, indicate that lignin removal can be accomplished by much milder means than hitherto regarded as possible. Such new methods point to future developments in the pulping of wood in which not only relatively lignin-free pulp of good quality is obtained, but in addition the lignin isolated is in a relatively unchanged condition and suitable for use as a new raw material for the chemical industry.

Design of Recovery Unit—Capacity of the modern spray type recovery unit for sulphate mills has been stepped up to above 200 tons with little demand for units of 100 tons and below, according to F. H. Rosencrantz of Combustion Engineering Co. Capacity limitation and superior performance of spray equipment has resulted in discontinuance of the rotary type Murray-Waern design.

Primary objectives of recovery unit in order of importance are: continuous reliable production, high reduction and recovery of chemical and steam production.

Two important obstacles to continuous reliable production are slag and the excess water in liquor to the furnace. The first difficulty is met by using vertical tubes spaced on wide centers arranged for gas flow parallel to tubes and providing adequate easily accessible lancing ports. The second obstacle is overcome by maintaining the solids in the liquor to the furnace consistently at the highest practical value. Excess temperature is essential to cascade evaporator control. High temperature of liquor to furnace is essential to drying in suspension.

Steam production under given conditions is a function of the amount of water in the liquor, the completeness of the combustion process, and the excess air and gas temperature at the exit. A typical heat balance under specific conditions shows steam production varying from 4.47 lb. down to 3.83 lb. from and at 212 deg. F. per lb. of dry solids.

Wet Strength Paper—Philip B. Taft of Resinous Products described the manner in which wet strength results when urea-formaldehyde resins are cured on the paper machine. Application of the resins by tub sizing is more successful than in the beater, he said. Ammonium or aluminum salts are used as catalysts to produce the necessary pH. Aluminum salts are preferred for most applications since they cause more rapid and more effective cure. A size consisting of 10 per cent resin solids, 10 to 12 per cent catalyst solids on resin solids, and tubbing at 130 deg. F., is recommended for satisfactory size stability and for effective results on the machine. However, no more exaggerated conditions should be imposed for good size stability.

Starches have an additive effect and glycerine detracts from wet strength development. Plasticizing is difficult and involves a varied treatment al-

though sugars and certain emulsified products have been of interest. Recovery of broke is carried out in the normal manner, unless the resin is cured. It is difficult to recover broke in the latter case.

Paper, sized with urea-formaldehyde resins, shows superior wet strength but otherwise is little different from the original stock. On storage at high temperatures and high humidities, wet strength may tend to decrease with time. Such paper is not considered toxic. The wet strength feature seems to be the result of reaction between cellulose and the urea-formaldehyde condensate which reduces the tendency of the cellulose to swell and the sheet to disintegrate.

Calcium Carbonate Pigment—A new type of calcium carbonate pigment, suitable for high grade paper coating work, was described by A. R. Lukens, C. G. Landes and T. G. Rochow of American Cyanamid Co. It is prepared by a special process involving water-grinding of natural calcite rock and mechanical separation to obtain suitable particle size and other characteristics. The product, known under the trade name Cal-Micro, is composed of rhomb-shaped and fragmental particles having an average particle size of 2-3 microns. It has advantages over the typical precipitated calcium carbonate in that it has a lower casein requirement and is much less water- and oil-absorptive.

Cal-Micro is unique in having a good color combined with an extremely low casein demand, both of which are important from a cost standpoint. This new pigment blends easily with all the commonly used pigments, especially china clays, and is best adapted for inclusion in moderate amounts, in many of the formulations now used in the industry.

Monel Jordan Bars—It has been the general opinion that non-rusting, corrosion resisting bars are intended principally for use in paper mills concerned with keeping the stock free from iron contamination, according to T. E. Lagerstrom, F. P. Huston and W. F. Burchfield of International Nickel Co. Such opinion, however, fails to recognize that irrespective of the grade of the stock, jordan bars are subject to corrosion in all jordans and this corrosion is frequently intensified by the presence of alum and slime control chemicals, they said.

Some board mills state that foreign substances in their stocks are likely to tear the filling out of the jordans. In such cases, it is not advisable to use a more costly corrosion resisting filling. However, when board mills have their jordans protected adequately against the inclusion of heavy foreign substances, the longer life of Monel bars makes their use economical.

Job Evaluation—A paper by R. H. Rositzke stated that a properly developed job evaluation plan is of great aid at the present time in outlining

the best course to follow in increasing production with limited skilled labor. A well rounded plan should provide for: (a) a natural sequence of promotion in training workers into higher skilled jobs; (b) an outline of the essential characteristics such an advancing worker should possess; (c) an exact description of duties to be performed by each worker.

In setting up such a plan, management should take into account the six major factors in job rating: mentality, skill, responsibility, mental application, physical application and working conditions. These are best used in a numerical weighting plan. In introducing the program, it must be made clear that it is the *job*, not the merits of the man on the job, that is being analyzed.

Such an evaluation gives a defined basis to a company for establishing: (a) wages for each job commensurate with duties performed; (b) comparison of wages with those of other paper mills or similar occupations in other industries; (c) discussion with employees about direction of their advancement or work factors; (d) basis for extra compensation benefits and other personnel policies.

Evaporator Performance—A frequent present-day problem in the pulp and paper industry is to increase the evaporator capacity in an existing mill, according to J. P. Rubush and G. E. Seavoy of Swenson Evaporator Co. Several important factors must be considered, such as ultimate capacity, use of existing equipment, available space, initial cost of additional equipment and final operating cost. The authors present data to enable quick determination of the relative economy of quadruple, quintuple, sextuple and even septuple effect evaporators. A typical problem is carried through to a solution considering many possibilities.

New Industrial Index—Louis T. Stevenson described a new index of industrial production and its relation to the paper industry. He pointed out that the trend of paper production has been upward for so long that it seems to be a settled habit of the industry. There is apparently no end in sight at the moment. The year 1940, according to latest advices, was the greatest year for paper production in the history of the country.

It seems clear that paper production and industrial production as exemplified by the new index move upward and downward at practically the same time if both series are adjusted for seasonal variation. However, the swings of paper production generally coincide in amplitude and timing more closely with those of nondurable goods, he said.

Heat Transfer—R. C. Jenness and J. G. L. Caulfield of the University of Maine discussed the results of their experiments on heat transfer coefficients in small-scale natural circulation evaporators. The evaporation of water

together with sucrose solutions and caustic soda solutions of a range of concentrations from 4.4–41.6 per cent was studied in two evaporators with different type heating coils. The overall heat transfer coefficient was found to vary according to the equation:

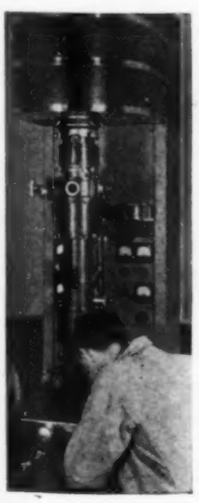
$$U \Delta t^m = \frac{a}{\left(\frac{\rho}{\mu}\right)^n \left(\frac{c\mu}{k}\right)^p}$$

where U is the H.T.C., μ is viscosity, c specific heat, k thermal conductivity, ρ density, Δt overall temperature differential and a, m, n, p constants.

The experimental value of Δt was constant in all cases, while values of the groups were found to be constant for two solutions in two different machines provided the type of liquid circulation remained the same. The constant a varied with type of heating surface and was materially increased when turbulent flow was believed to exist.

ELECTRON MICROSCOPE

America's first commercially built electron miscroscope was described last month at a meeting in New York's Chemists' Club. The new machine (see cut) enables scientists to picture minute objects at 100,000 times natural size. It is now being operated in American Cyanamid Co.'s laboratories at Stamford, Conn. in the development of new medicines and chemicals. Dr. R. B. Barnes of that company stated that the new instrument had participated in the development of a new calcium carbonate pigment for the paper industry. Fine particles of precipitated chalk, long believed to have no crystalline structure, were shown to be nearly as perfect as large crystals.



James Hillier of RCA Research Laboratories, co-developer of the electron miscroscope, described the principle of its operation. It utilizes a beam of swift-moving electrons focussed by electromagnetic "lenses" to produce images of minute objects on fluorescent screens or on photographic plates. The new instrument is 20 to 50 times more powerful than the ordinary microscope.

Dr. Stuart Mudd of the University of Pennsylvania Medical School participated in the symposium by describing the important application of the electron miscroscope to the study of bacteriology.

An open message to Johns-Manville Employees*

by LEWIS H. BROWN, *President, Johns-Manville Corp.*

AS THIS NEW YEAR BEGINS, I am glad to have this opportunity to discuss with you the big job facing all of us during 1941.

Because of the demands placed on every business and every citizen by our nation's need for an adequate defense, our work is clearly cut out for us. We must contribute to the utmost of our ability to the defense building program.

Already, one-third of all J-M production is demanded for defense requirements. And this demand is growing daily. Some of it has been due to the increased need for J-M products for direct government projects. Some of it is the result of sales to expanding industries which use our products and are themselves working at top speed to fill government orders.

* * *

With every increased demand Johns-Manville has stepped up production to meet it. Many departments of our seventeen mines and plants have been affected by the defense needs and are now operating seven days a week, 24 hours a day. The working day is divided into three shifts of eight hours. At many locations, four shifts of employees work 40 hours each week to assure full production of the machines 7 days a week. Thus, work on Saturdays and Sundays is distributed fairly among everybody affected.

As the defense program develops we will necessarily have to step up our production more and more. This means we will have to find all the "bottlenecks" and increase the productivity of every machine.

Of course, most of us would prefer that industry's policy could be "business as usual." But these are not normal times. Business cannot be conducted "as usual" in an emergency. Defense comes first.

* * *

As a company, J-M is not going to let anything or anybody stand in the way of expediting the government's efforts to complete the defense program. This means co-operation by all of us, by management and by employees.

Naturally we shall all be called upon to make sacrifices. Taxes will be heavier. Raw material and manufacturing costs will probably rise. We shall all have to bear the burden.

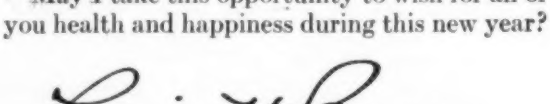
Under these circumstances we shall have to redouble our efforts to reduce waste and increase efficiency so that we not only will be able to deliver quality goods in record time, but keep prices in check. By doing this we shall be helping to keep the costs of the defense program down. As taxpayers we shall indirectly benefit through this economy, for all of us must pay our share of the enormous defense bill.

* * *

There is no doubt in my mind that J-M jobholders can be relied upon to do their part. You have already shown the spirit of real co-operation and patriotism which is so necessary. For your co-operation I want to thank you.

I know that I can count upon your continued support and loyalty in our common effort to help keep this land of ours safe and free.

May I take this opportunity to wish for all of you health and happiness during this new year?



**Although not directly engaged in the manufacture of munitions or armaments, Johns-Manville manufactures many products essential to the operation of industries so engaged. This message, stating Johns-Manville's policy in support of the nation's defense program, originally appeared in the January, 1941, issue of the* News Pictorial, *J-M employee magazine.*

New Titles, Editions and Authors

Chem & Met BOOKSHELF

STATISTICAL SERVICE

CHEMICAL FACTS AND FIGURES. First edition. Published by the Manufacturing Chemists' Association, Washington, D. C. 219 pages. Price 65 cents (75 cents west of Mississippi).

Reviewed by *S. D. Kirkpatrick*

RECOGNIZING the need for an annual publication covering all the significant statistics of the American chemical industry, its oldest and strongest trade association has undertaken to compile and publish such a volume. This first edition, dated last November, is a most comprehensive and useful tool for any chemical executive, engineer or technologist.

Full advantage has been taken of the experience which the M.C.A. staff has gained through whole-hearted and painstaking cooperation with *Chem. & Met.* editors in their Sept. 1937 and Sept. 1939 issues of "Facts and Figures of the American Chemical Industry." Practically all of the same studies and statistical series first brought together in these issues have been continued and brought more nearly up-to-date. In addition, the M.C.A. compilation includes a great deal more detailed data for production, imports and exports of individual commodities and in most instances have carried these figures back to 1929 or earlier years where especially significant. Authority for all this information, which has been compiled from Governmental and trade sources, is carefully noted so that original references may be readily consulted for additional data and explanation as to coverage.

"Chemical Facts and Figures" purposely avoids any attempt to interpret or evaluate the economic and technical significance of its data. The only exception noted by this reviewer is in the description of the new Federal Reserve Index for chemical production which ends with the significant statement, "Question has been raised as to whether the new index reflects a fully accurate picture for the chemical industry." Our view is that it most certainly does not.

It is a bit unfortunate that the Government's delay in completing the 1939 Census of Manufactures made it necessary for M.C.A. to issue its 1940 volume with only partial and preliminary 1939 totals for many of the important industrial series. Some of these figures have since been released and are included in the report accompanying this February issue of *Chem. & Met.* It is to be hoped that in future volumes the official information can be available more promptly to the industry.

Manufacturing Chemists' Association is to be congratulated in providing its members and their customers with a statistical service comparable, if not superior to, that which the automobile, petroleum, bus and other trade associations have long established in their respective fields.

THE RING INDEX. By *Austin M. Patterson* and *Leonard T. Capell.* Published by Reinhold Publishing Corp., New York, N. Y. 661 pages. Price $8.

AFTER nearly 20 years of study and work, an index of more than 4,000 chemical compounds makes its appearance. A critical book review is neither indicated nor necessary. Statement of aims and accomplishment will be sufficient to enable each of our readers individually to determine its value.

The book is a check list and reference for numbering and naming ring structures from the single ring Triarsirane up to and including one 19-ring compound. Each entry includes the structural formula. Preferred, common and other names are given, together with at least one reference to the original literature. Each structure is given a R. I. (Ring Index) number by which it may be identified. This scheme permits rapid location of a compound by reference to the book's index. It also may be used in future literature references for identifying a structure. The book's 16-page introduction explains nomenclature, numbering and other features of the entries. A reprint of the proposed international rules for numbering ring systems will be found in the appendix.

ALL ABOUT PLASTICS

MODERN PLASTICS CATALOG, 1941, published by Breskin Publishing Corp., New York, N. Y. 476 pages. Price $3.50.

HERETOFORE this catalog has been published as the October issue of *Modern Plastics.* The last one appeared in 1939. This new plastics catalog has just been released and is independent of the regular issues of the magazine.

The opening section on "plastics engineering" contains a diagrammatic and pictorial flowsheet for the production of each of nine plastics. They remind one of the more elaborate flowsheets that have been appearing in *Chem. & Met.* for the past two years, although this magazine's name does not appear very conspicuously on the page of acknowledgments.

The section dealing with "materials" includes a discussion of the process, general characteristics, recent developments, forms available, methods of fabrication, typical applications, and trade names for each of the principal plastic materials, including synthetic rubbers.

So much has been happening in the development of "molding technique" and "equipment" during the past year or two that these chapters should be carefully read and the statements analyzed for effects on trends in the consumption of thermoplastics and thermosetting materials.

"Coating materials," their characteristics, principal applications and other information are covered in a special section. Brief descriptions of the synthetic fibers, nylon, Vinyon, protein and rayons are given in another section.

COMMERCIAL FINISHES

LACQUER AND SYNTHETIC ENAMEL FINISHES By *Ray C. Martin.* Published by D. Van Nostrand Co., New York, N. Y., 526 pages. Price $5.50.

Reviewed by *W. L. Abramowitz*

UPON studying the book, this reviewer's principle thought was, "Any purchaser will certainly get his money's worth." The industrial importance of lacquers being so well known, any comments thereupon would be superfluous. The reader is therefore spared the necessity of plodding through an extraneous essay before finding out what the book is about.

The commercial types of nitrocellulose and film scrap are described and their properties discussed. Three chapters are detailed for solvents, diluents, latent solvents, plasticizers, resins and pigments. The presentation of data on properties is somewhat elementary and fragmentary but definitely useful and it is difficult to see how it could be improved without becoming a manufacturer's catalogue.

The chapter on equipment and plant for manufacturing and handling lacquers is excellent in its thoroughness and detail, particularly in view of the danger to personnel and to property unless complete safeguards are taken.

The formulation of some 300 different types of lacquers is touched upon and representative formulas given which should furnish sufficient preliminary information for further development. A special chapter is devoted to furniture finishes.

One of the perplexing problems of the lacquer research chemist is ade-

quate test methods to evaluate the performance of his products. The chapter on analytical methods includes not only chemical analysis but also physical tests such as abrasion, toughness, flexibility, hardness, tensile strength and color.

A most useful section is the one on faults and corrections in lacquer formulation which points out in fair detail how poor films may result and how to recognize and prevent defects.

There is a 100-page glossary of technical terms which should be of value even to the expert. There are, however, some minor inaccuracies. For example triethanolamine is called an emulsifying agent which it is not but becomes one only when used as a neutralizing base with fatty acids or sulphonated oils. Carbon black is called microscopic in size with dimensions of the order of 1000 A to 500 A which are actually considerably below microscopic perception. Recent electron microscope observations have shown that carbon black particles as seen under the ordinary microscope are aggregates, the individual members of which are in the sub-colloidal range. An index to the book would have been helpful.

PATENT LAW

HANDBOOK FOR CHEMICAL PATENTS. By *Edward Thomas.* Published by Chemical Publishing Co., New York, N. Y. 270 pages. Price $4.

Reviewed by *Robert E. Sadtler*

WRITTEN on a subject which provides more than half of all patent litigation, this handbook gives considerable useful information for all who are concerned with chemical patents. There are 23 short chapters, each of which covers some aspect of patent laws and related subjects.

Opening with a sales talk chapter on "You Can't Keep a Chemical Secret," the book continues with discussions of problems raised by chemical patents, nature of a patent and suggestions for specification writing. Three important subjects, anticipation, infringement, suits and evidence, require nearly one-third of the book's pages. Other chapters of importance are Interferences, Double Patenting, Assignments and Licenses, Foreign Patents, Nature and Date of Inventions, and Interpreting the Specification. Following chapter 23 is an interesting article on "Suggestions for Exploiting Chemical Inventions." This is followed by a reprint of four typical chemical patents and following these are a full table of the numerous cases cited in the book and an index to the subject matter.

A few statements made by the author may be questioned. For example, the impression is given in chapter four that a patent is a contract whereas it is generally recognized as a grant. And in discussing the cost of foreign patents, the author states that they average about the same as in the United States. Actually the cost is

usually four times as great. These and other small errors, however, will undoubtedly be corrected in subsequent editions of the book.

BRITISH STARCH PRODUCTION

STARCH AND ITS DERIVATIVES. By *J. A. Radley*. Published by D. Van Nostrand Co., New York, N. Y. 346 pages. Price $6.

Reviewed by *F. A. Frankenfield*

THIS book is an excellent review of the physical chemistry and literature pertaining to starch. The author has also prepared a summary on production methods pertaining to starches and starch products as well as industrial applications of these materials, particularly their uses in the adhesive, textile and paper industries.

Comparatively less time is devoted to the other products that are obtained indirectly from starch such as ethyl alcohol, acetone, glucose, etc. Several chapters are also devoted to general examination and analysis of starch and starch products.

An excellent bibliography is included at the end of each chapter, which should make this book helpful to the starch worker.

However, some of the production methods for starches, dextrines, etc. are not completely up to date so far as American standards are concerned. His chapter devoted to the production of ethyl alcohol, although it might be typical of English methods, is hardly consistent with procedure necessary to get good production in American factories.

There are a few terms which are a bit confusing. For example, he occasionally refers to starch slurry or starch granules in suspension as "paste." Similarly, he frequently uses trade names for pastes, gums, etc. for products used in England without further identifying them, making it difficult for one who is not familiar with these products to know to what he is referring.

Taken as a whole, though, the book is well written and is recommended for any starch worker who wants a concise summary of theoretical as well as practical aspects of starch chemistry.

THE MANUFACTURE OF COMPRESSED YEAST By *F. G. Walter*. Published by Chemical Publishing Co., Inc., New York, N. Y. 254 pages. Price $6.

Reviewed by *Gustave T. Reich*

THE BOOK is concerned especially with the manufacture of compressed yeast as practiced in England. Following a brief description of the varieties of yeasts, molds and enzymes, the various subjects are divided in eight chapters, each with appropriate subdivisions.

First, the subject of the isolation of the yeast, then raw materials, their preparation and calculations in admixtures are discussed in great detail. Then follows the method of mashing and differential fermentation of grain

brew. Chapter V discusses the production of yeast from molasses and inorganic nitrogen, according to the continuous and batch methods during non-alcoholic fermentation.

Another chapter deals with the recovery of yeast as a by-product from whiskey and gin distillery worts. The last two chapters discuss the production of dried yeast, the layout of a yeast plant and construction of the equipment required. The testing, specifications and methods of analysis of the raw and finished materials are described in the closing section.

From the American viewpoint, the weakness of the book lies in its failure to indicate the latest developments in this country. Irradiation of the yeast, vitamin content as well as methods of drying besides truck tray drying are omitted. Literature and patent references are missing. These omissions it is hoped will be remedied in the next edition as the book is not only to be recommended to the specialist in compressed yeast, but should be of interest to everyone in the fermentation industry.

SABOTAGE AND HOW TO GUARD AGAINST IT. By *Harry D. Farren.* Published by National Foremen's Institute, Inc., Deep River, Conn. 56 pages. Price $1.

Reviewed by *S. D. Kirkpatrick*

ALTHOUGH subtitled, "A Manual for Industrial Workers, Supervisors and Executives," this little book is more in the nature of a "pep talk." It is an exhortation addressed primarily to work supervisors, urging on them the extreme importance of their responsibility in the present emergency. Rather lurid accounts of what happened at Kenvil, N. J. on September 12, 1940, at Picatinny on September 23, at Fernwood, N. J. and at Terre Haute, on October 5, are given. These "industrial accidents" are compared with the known cases of sabotage at Black Tom Island in 1916 and at Haskell, N. J. in 1917. The comparisons are interesting if not convincing.

The eight pages of detailed instructions are well worth study by all chemical engineers. Those in defense industries will compare these instructions with those in the much more detailed pamphlets of the Federal Bureau of Investigation (see *Chem. & Met.* December 1940, p. 828).

THE WORKING, HEAT-TREATING AND WELDING OF STEEL. Second edition. By *H. L. Campbell.* Published by John Wiley & Sons, New York, N. Y. 230 pages. Price $2.25.

Reviewed by *W. G. Hildorf*

THIS textbook provides the material for an excellent introductory study to the metallurgy of steel. In addition to university students, it should be of interest to anyone wishing to know these subjects. Starting with the development of iron and steel products, one has the opportunity of becoming familiar with the various processes used in making these products as well

as subsequent processes, equipment and tests.

The book has a large number of well-chosen, up-to-date illustrations showing equipment, photomicrographs, line drawings and tables. These are of real value, not only for a better understanding of the text, but also for getting an idea of the actual construction and appearance of equipment and machines.

The review questions at the end of each chapter are well chosen. They bring out the most important points and are a valuable part of the book.

A thorough knowledge of this book, together with the supplementary reading suggested by the author, would provide anyone with a good education on the working, heat-treating and welding of steels.

NON-FERROUS FOUNDRY PRACTICE. By *J. Laing* and *R. T. Rolfe*. Published by D. Van Nostrand Co., New York, N. Y. 336 pages. Price $6.

Reviewed by *V. P. Weaver*

EXCELLENTLY written, this volume is a welcome and useful addition to the rather short list of up-to-date books on foundry practice.

The text is interestingly informative on such subjects as furnaces, melting practice, pouring, temperatures, molding sands, ramming, venting, feeding heads, gating and on the metallurgy of non-ferrous alloys including composition, alloy structure, mechanical properties and effect of impurities.

A third of the book deals with the tin, bronzes, another third covers brasses, other bronzes, nickel silver and copper-nickel alloys and the remainder deals principally with aluminum alloys plus a chapter on magnesium alloys.

Mechanical properties are shown in nearly 100 tables and there are over 100 illustrations (47 drawings, 22 photographs, 25 micrographs and 16 diagrams) plus about 200 references to other literature.

Because of its well balanced and orderly presentation of foundry procedure and metallurgy, it should be useful to foundry men, metallurgists, engineers and many others.

ELEMENTARY QUALITATIVE ANALYSIS. Third edition. By *J. H. Reedy*. Published by McGraw-Hill Book Co., New York, N. Y. 156 pages. Price $1.50.

WITH approximately one-half of its pages devoted to the study of cations and half to anions, the laboratory experiments given in this textbook will acquaint the student with the reactions of all the common ions. These have been grouped according to the usual qualitative scheme. And following the experiments are the directions for systematic analysis of the group. Throughout the text, notes and questions are interspersed to help impress the reactions and reasons for various procedures. The directions frequently call for the use of a centrifuge. Use of this method of removing precipitates will greatly speed routine analyses.

CURRENT LITERATURE ABSTRACTS

WELDED JACKETED PRESSURE VESSELS

DOUBLE-WALLED pressure vessels made by pressing the jacket against the inner wall at intervals and welding the two at the point of contact have been tested for use in chemical operations. In particular the welding stresses and stresses set up by inside pressure were investigated. Because of its many approximately hemispherical depressions the jacket responds better to stresses than does the vessel wall. To justify welding instead of riveting the welds must be sound and strong since they must withstand high pressure stresses. To ascertain the probable explosion hazard a vessel of this type was made with a weak wall and subjected to bursting pressure. The result indicates that such pressure vessels are not likely to explode becaue the weakest weld fails first and so acts as a safety valve. A recent improvement in welded jacketed pressure vessels comprises indenting both the inner wall and the jacket where each weld is to be made. Approximately twice as many welds can be made in this way so that strength is correspondingly increased. Hence thinner walls may be used for a given strength.

Digest from "Study of Welded Jacketed Pressure Vessels in the Chemical Industry," by E. Block, *Chemische Fabrik* **13**, 281, 1940. (Published in Germany.)

ACTIVATED CARBON FROM SEWAGE SLUDGE

COKE from retorting sewage sludge contained 22 to 24 percent carbon. Several treatments were tried for increasing the carbon content in order to obtain activated carbon. No significant enrichment in carbon content was obtained by treatment in an air blast. Fractional sedimentation in a brine with specific gravity 1.05 gave some enrichment (2.5 percent in 59 percent of the original sample, with one fraction rising to 33.3 percent carbon). Boiling in tap water for 30 minutes gave less than 2 percent water extract and no significant increase in carbon content. Finally a combination of acid and alkali treatment was developed which substantially enriches sewage sludge coke in carbon. First the powdered coke is boiled 30 minutes with 5 cc. hydrochloric acid (specific gravity 1.195) and 15 cc. tap water per g. of coke. The powder is collected on a filter, washed with warm water, dried and mixed with 50 percent of its weight of granular sodium hydroxide and 15 cc. tap water per g. of coke. Again the mixture is boiled 30 min., settled and filtered. After washing with warm water the solid is dried at 105 deg. C. This treatment raises carbon content from 22-25 percent up to 36-37 percent, and in the case of coke from activated sewage sludge a carbon product with 49.35 percent carbon was obtained. Adsorption capacity of the carbon was increased by the same treatment from 0.75 mg. of methylene blue per gram, or 15.8 mg. of iodine per gram, to 12.65 mg. of methylene blue or 65.6 mg. of iodine per gram of sample. Thus coke from sewage sludge is potentially a source of activated carbon.

Digest from "Residual Coke from Retorting Sewage Sludges," by S. Shibata and J. Shioya, *Journal of the Society of Chemical Industry of Japan* **43**, 331B, 1940. (Published in Japan).

CONTROLLING CHEMICAL OPERATIONS

THE COST of operation control in a large chemical plant (e.g. for nitrogen fixation, hydrogenation or synthetic rubber manufacture) is generally between two and five percent of total capital costs. This estimate does not include development laboratories. Savings are difficult to estimate, but in the single item of accuracy in meters and control instruments the margin of error has been brought down from about three to about one percent. Losses which hitherto passed undetected are thus halted by modern instruments. Among recent developments are devices for immediate detection and indication of contamination by catalyst poisons in expensive catalysts, and means for preventing oxidation of gas purification solutions. Other examples are instruments for extremely high pressure operations now employed in chemical plants, and extension of spectrometric analysis into the infrared region. Control instruments are classified in four groups:

1. Those responding to rise or fall of a given physical property; when the property is concentration the instrument serves to maintain composition of mixtures.
2. Those which are adjusted to a predetermined value of a physical or chemical constant.
3. Those responding to a regulator impulse so that they follow the changes in a given property registered on a meter.
4. Those which control operations by making adjustments at fixed intervals or at variable rates depending on the deviation from a predetermined level.

Digest from "Problems, Organization and Importance of Control in Chemical Operations," by Paul Gmelin, *Chemische Fabrik* **13**, 197, 1940. (Published in Germany.)

PULP GRINDER PROBLEMS

JAMMING of pulpwood with consequent machine stoppage is prevented in an improved continuous pulp grinder by arranging the feed chains so that the wood cannot take any other than its intended horizontal position as it approaches the pulpstone. Rate of feed is automatically adjusted according to the load on the stone. When the load lightens, the machine feeds pulpwood faster to the stone and returns to slower feeding as the load increases. Introduction of continuous pulp grinding made it feasible to grind thin hot pulp instead of the thicker pulp for-

merly ground at a lower temperature and thereby effected notable economies, especially in pulping newsprint. An improvement in continuous pulping is the new nonjamming chain feed which brings out all the inherent superiority of the chain feed principle over the screw conveyor type of feed for pulp grinders. It permits efficient utilization of the pulpstone without using so much of the stone's periphery as to cause excessive grinding. Some grinder designs expose more than six feet of the pulpstone periphery to pulpwood with the result that fibers torn from the wood at the beginning of this path are ground too fine before the end of the path is reached. Grinders with the improved chain feed give good efficiency with only about three feet of the pulpstone periphery exposed to pulpwood.

Digest from "Pulp Grinder Problems," by Max Wintermeyer, *Wochenblatt für Papierfabrikation* 71, 513, 529, 547, 1940. (Published in Germany.)

SILVER PLATING

Passivation of silver at the cathode during electrodeposition has been attributed to oxygen in the electrolyte, presence of semivalent silver, and organic impurities. Carefully controlled electroplating tests showed that passivation is not due to oxygen in the electrolyte, nor to semivalent silver. Further tests were therefore made with electrolyte which had been freed from organic impurities by oxidation in a current of oxygen activated by platinized platinum. There was almost no passivation when silver was plated out of solutions treated in this way. When the catalytic oxidation of organic matter was carried out at 140 deg. F., the electrolyte caused no passivation whatever. Hence it is clear that the actual cause of passivation during electrodeposition of silver is contamination of the electrolyte with organic matter. The probable mechanism of passivation is adsorption of the organic matter on the active surface of the cathode.

Digest from "On Passivation of Silver During Electrodepositing," by A. T. Vagramyan, *Compt. rend. (Doklady) acad. sci. USSR* 27, 803, 1940. (Published in Russia).

AUTOMATIC AND REMOTE CONTROL

With the magnetic switch as the basic element, numerous devices for automatic or remote control have been developed for chemical operations. Examples include momentary contact (pushbutton) switches for manual remote control of light, heat or power and auxiliary contacts to facilitate safe operation of motors by unskilled labor. For completely automatic operation of pumps, compressors and refrigerating machines a permanent contact device is employed with a rotating switch with a simple auxiliary contact and a thermostat.

Among recent improvements in control devices there is a completely automatic compressor with a three-way valve operated by an electromagnetic switch setup which includes hydraulic control of cooling water. Another pro-

vides remote control for the steam valve of a drier, using as contact device a tension thermostat with visible adjustment scale, and as the controlling switch a mercury tube contact. The position and operation of this mercury switch can be observed through a window. For operating valves, slides or throttles when rate of flow of a liquid must be changed slowly and gradually an electrohydraulic setup is used which is versatile in its applications and can be directly connected to valves or the like for smooth, practically silent opening or closing. Explosion-proof switches are much in demand for operation in atmospheres which do or may contain explosive vapors. Among other safety devices utilizing electrical control is a contact wire in front of roll mills, connected to a roll reversing mechanism so that operators or their clothing cannot be caught and drawn into the rolls.

Digest from "Electrical Automatic and Remote Control Devices in the Chemical Industry," by Johann Kuhn, *Chemische Fabrik* 13, 321, 1940. (Published in Germany.)

MEASURING ACID RESISTANCE OF GLASS

THE KOHLRAUSCH conductometric method has been adapted to stability tests of glass used in chemical apparatus. The results may be expressed either in terms of time required to effect equal destruction, or by plotting a curve showing degree of destruction as a function of time. The tests were made with water and with dilute hydrochloric acid on Jena glass in comparison with two other glasses used for chemical equipment. Similar tests were made with an electrode glass, a molybdenum glass and lead metasilicate. Jena glass ranked highest in stability, followed by the other two apparatus glasses, then by molybdenum glass and electrode glass. Lead metasilicate was sensitive even to water and was attacked very rapidly by dilute hydrochloric acid. Results of the conductometric tests agree with results of various chemical tests in that the various glasses receive about the same stability ratings. In convenience, simplicity, sensitivity, applicability to a wide range of glasses and reagents and dependability as an indication of probable behavior in actual service the conductometric test for glasses compares favorably with the various chemical tests.

Digest from "Application of the Kohlrausche Method to Measuring Chemical Stability of Glasses," by V. S. Molchanov, *Journal of Applied Chemistry (USSR)* 13, 934, 1940. (Published in Russia.)

PARTITIONED STEAM TRAP

HEAT ECONOMY by utilizing the heat from vapor and condensate for preheating incoming liquid greatly improved evaporator performance. The maximum efficiency achieved in this way has now been still further improved by introducing a drain trap having two chambers. While ordinary

A complete technical manual of principles, instruments and tactics

This book is the first written from an American viewpoint, giving a full and authoritative treatment of all aspects of chemical warfare. Its 700 pages of detailed facts on the scientific fundamentals, tools, and tactics of chemical warfare and the probable scope of this weapon in future war will answer many questions of the military, the chemical industry, and of civilians.

CHEMICALS IN WAR

By AUGUSTIN M. PRENTISS
Lieutenant Colonel, Chemical Warfare Service
United States Army

739 pages, 6 x 9, 167 illustrations, $7.50

The purposes of this book are:

1. To trace the development of the art and science of chemical warfare from its beginning in the World War to the present time.
2. To present an American viewpoint on chemical warfare, and
3. To make available to the public an authentic text on a much misrepresented and misunderstood subject of great importance to our future national security.

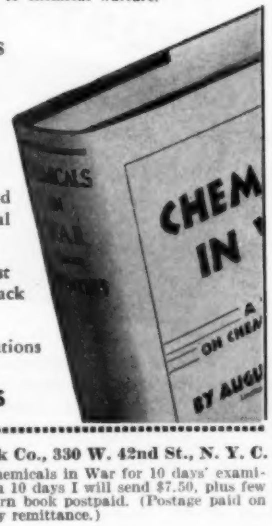
In carrying out these purposes the book gives lucid and detailed descriptions of every fact, within possibilities of public disclosure, which can contribute to a knowledge of such topics as:

—**fundamentals of chemical warfare: how it is carried on, what it is expected to do, the military organization required, etc.**
—**the chemicals which have been used in combat, what their effects are, how they are used**
—**technique and tactics of chemical warfare among infantry, cavalry, chemical troops, air corps, etc., including the evolution and development of the use of chemicals in battle from the early World War period to the present day**
—**means and methods for protection against chemical attack, both for military units of various types and for civil population**

Besides these military aspects of the subject the book contains an important chapter on the relation of the chemical industry to chemical warfare. The book also presents an impartial view of the use of chemicals as compared with other weapons of war and other facts that must be considered in any analysis of the international situation with regard to chemical warfare.

5 Big Sections

I. Fundamental Considerations
II. Chemical Agents
III. Technique and Tactics of Chemical Warfare
IV. Defense Against Chemical Attack
V. General Considerations



SEE IT 10 DAYS

McGraw-Hill Book Co., 330 W. 42nd St., N. Y. C.

Send me Prentiss—Chemicals in War for 10 days' examination on approval. In 10 days I will send $7.50, plus few cents postage, or return book postpaid. (Postage paid on orders accompanied by remittance.)

Name ....

Address ....

City and State ....

Position ....

Company ....M. 2-41

(Books sent on approval in U. S. and Canada only.)

This New Explosion Proof Micro Switch . . .

. . . is already at work in hazardous locations in Paint Factories, Rubber Cement and Chemical Plants, in Refineries, in Distilleries, in Grain Elevators and other places.

THE new Explosion Proof Micro Switch has been accorded ready and wide acceptance throughout the Process Industries. Its small size, compactness, rugged construction and precise, snap-action with small movement and low operating pressure, makes it adaptable to functions and conditions for which no other switch has been heretofore available.

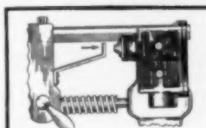
The Explosion Proof Micro Switch is extremely small in size, occupying less than 18 cubic inches, and measures only 2½" high x 2" wide x 3⅝" long; it weighs only 2½ lbs. It is single pole, double throw and is available with three types of actuators. Conduit opening is standard ½" and accommodates three No. 14 rubber insulated wires.

It is listed by the Underwriters' Laboratories for service in hazardous locations — Class I, Groups C and D; Class II, Group G — with a rating of 1200 watts up to 600 volts AC, or ½ H.P. at 460 volts AC motor loads. Streamlined cadmium plated cast iron housing is drilled and tapped for mounting on either of four sides. A universal mounting plate can be provided where needed.

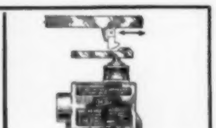
Where Water, Oil and Dust Exist, the Sealed Die-Cast Micro Switch is Proving Itself . . .

The Sealed Die-Cast Micro Switch fills as definite a need in the Process Industries as the Explosion Proof Micro Switch. This switch, however, is not intended for hazardous locations. It is designed for use where liquids are used, where equipment must be washed frequently and where machines operate in abrasive, dust laden air. Its small size, precise operating characteristics and long life make the Sealed Die-Cast Micro Switch ideal for these requirements.

It occupies a space of only 8½ cubic inches; length 2 15/16", height, 2 13/16", width 1". Housing is of die-cast material suitably gasketed. Tightly sealed at the plunger with a bellows of synthetic rubber which will withstand millions of flexes. The Sealed Die-Cast Micro Switch is Underwriters' Listed with a rating of 1200 watts up to 600 volts AC, or ½ H.P. at 460 volts AC motor loads.



***Lathe Carriage Stop**—Lathe carriage actuates the Die Cast Micro Switch at end of travel.*



***Hinged dog on slide** actuates sealed metal clad Micro Switch only on one direction of dog.*

MICRO SWITCH is the Name of a Particular Product, Not a General Term.

Complete details regarding both the Explosion Proof Micro Switch and the Sealed Die-Cast Micro Switch are covered in specially prepared Data Sheets. Write for them.

MICRO (MS) SWITCH

Manufactured in FREEPORT, Illinois, by Micro Switch Corporation. Sales Offices: New York, Chicago, Boston

traps take out only condensate and no steam they nevertheless contain steam because pressure release permits part of the trapped condensate to evaporate. Operating with steam at four atm. pressure the resulting temperature drop may be as much as 50 deg. C. and useful heat is accordingly lost from the condensate.

The new partitioned trap has a float in one chamber and a valve in the other, so arranged that the float can operate the valve. Condensate enters the first chamber, passes from it to a heat exchanger and then to the second chamber. This arrangement permits the flow of liquid condensate to and from the trap to be regulated so that no fresh steam escapes into the preheater. As a result the preheater is always filled with water and no steam can escape from the evaporator side to the heat exchanger. There is practically no pressure drop in the first chamber, containing the float, and from this to the second chamber there is only the small pressure drop incurred in passing through the heat exchanger. For practical purposes the partitioned trap postpones pressure release until after the heat in the condensate has been utilized in the preheater.

Digest for "Use of the Double Chamber Steam Trap in Evaporators," by W. Hofmann, *Chemische Febrik* 13, 343, 1940. (Published in Germany.)

SPINNING GLASS FIBER

Average diameter of a glass filament decreases in a regular but not linear curve as spinning velocity increases. Starting at a diameter of nearly 16 microns when thread is being withdrawn at a rate of about 260 meters per min., the diameter falls to approximately 9 microns when speed rises to 800 m. per min. High spinning speed also means increased breakage hazard. The average amount of glass withdrawn from a melt through the spinneret is a constant, independent of spinning speed in the range from 300 to 750 m. per min. The amount of glass passing through a spinneret orifice per minute is about twice as great in mechanical thread drawing as when a drop of melt is allowed to fall from the orifice by its own weight. Diameter can be calculated with a fair degree of accuracy from the weight of fiber on a reel, the density of the glass, the known spinning speed, the spinning time and the average thread number during the spinning operation.

Digest from "Studies in Glass Spinning," by Ikutaro Sawai and Masso Mine, *Journal of the Society of Chemical Industry, Japan* 43, 351B, 1940. (Published in Japan).

SEPARATING GASES

The Clusius thermal diffusion tube for separating gases comprises, in its simplest form, an electrically heated wire stretched along the axis of an externally cooled tube. Its effect depends on diffusion of light gas molecules toward the hot wire, and of heavy molecules toward the cold tube wall. The temperature gradient must

not be too large because radiation losses become excessive and the separation effect is impaired at very high temperatures. Thermal stability of the gases must also be considered. Thus, hydrogen chloride withstands temperatures as high as 700 deg. C. while hydrogen bromide must not be heated above 350 deg. C. To avoid the expense of electric heat a new diffusion separator has been designed for flame heat. It comprises two concentric metal tubes, the inner being heated by an elongated gas flame while the outer tube is water-cooled. The inner tube is five meters long, 40 mm. wide and is made of copper one mm. thick. The outer tube is brass, with four mm. space between the walls. The upper end of the separator carries a metal gas reservoir, capacity eight liters. For gases which corrode copper a similar separator has been made in glass, but it requires electrical heat. The metal separator, in a trial with equal parts by volume of CO_2 and N_2, gave 100 percent CO_2 at the bottom of the tube in 315 min. The temperature of the heating gas leaving the tube was about 400 deg. C. Experiments on the use of waste heat for economical operation are needed.

Digest from "Development of the Separator Tube Process," by K. Clusius and H. Kowalski, *Chemische Fabrik* 13, 304, 1940. (Published in Germany.)

LABORATORY COMPRESSOR

A LABORATORY compressor, capable of giving 300 atm. pressure in continuous operation or 400 atm. in short runs, has been constructed in compact form which does not require much space yet offers capacity enough for semi-works operations. The maximum available output capacity is 400 liters per hr. The design is such as to permit safe handling of toxic and explosive gases.

The new machine is a three-stage piston compressor, capable of operating at 100, 200 or 280 r.p.m. Because its small size and special construction permit rapid heat dissipation it can be used at unusually high compression ratios, namely 1:8.7 in the first stage, 1:9 in the second stage and 1:4 in the third stage. These ratios are for continuous compression at 300 atm. pressure. For short runs at 400 atm. the ratios may be slightly higher (1:9, 1:8, 1:5.3). A combination of water cooling and air cooling is employed. This compressor may be used for hydrogen, nitrogen, hydrogen sulphide, carbon monoxide, carbon dioxide, methane, air, illuminating gas and the like. This type of compressor is not safe with oxygen because of the effect of highly compressed oxygen on lubricating oil (explosion hazard). With proper precautions the machine may be used for compressing acetylene. Corrosive gases may be compressed if the machine is constructed from properly selected metals for resisting the selected gas.

Digest from "High Pressure Piston Compressor for Laboratory Use," by Hermann Vollbrecht, *Chemische Fabrik* 13, 360, 1940. (Published in Germany.)

GOVERNMENT PUBLICATIONS

Documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington, D. C. Send cash or money order; stamps and personal checks not accepted. When no price is indicated, pamphlet is free and should be ordered from bureau responsible for its issue.

Farmers in a Changing World. This is the equivalent of the Agricultural Yearbook, each annual volume of the series now being given a distinctive title. U. S. Department of Agriculture; $1.50 (clothbound).

Agricultural Statistics 1940. The companion statistical volume to Farmers in a Changing World, giving data for 1939 operations. U. S. Department of Agriculture; 75 cents (paper).

Income Data. Recent publications of the Department of Commerce and Treasury Department on this subject are: Monthly Income Payments in the United States, 1929–40, by Frederick M. Cone. Bureau of Foreign and Domestic Commerce, Economic Series No. 6; 10 cents. The Bureau of Internal Revenue *final* reports on Statistics of Income for 1937 covering both corporation and individual tax returns; 25 cents each for both parts. Bureau of Internal Revenue *preliminary* reports on Statistics of Income for 1938 covering both corporation and individual tax returns; 5 cents each for both parts. The data in these four documents permit an analysis of individual buying power and corporation activity.

Helium-Oxygen Mixtures for Alleviation of Tubal and Sinus Block in Compressed Air Workers, by J. W. Crosson, Roy R. Jones, and R. R. Sayers. U. S. Public Health Service, Reprint No. 2191; 5 cents.

Disinsectization of Aircraft, by C. L. Williams. U. S. Public Health Service, Reprint No. 2169; 5 cents.

Engineer Field Manual—Communications, Construction, and Utilities. War Department FM 5–10. This booklet is an excellent guide to high-grade field practice in engineering and construction work as typified by the Corps of Engineers of the U. S. Army. $1 (paper).

Annual Reports. Each of the Departments and Bureaus of the Government prepares an annual report, most of which have appeared or are appearing at this time. Those wishing to review the work of any special government agency should address that institution, asking for the annual report for the fiscal year ending June 30, 1940.

Package Sizes for Agricultural Insecticides and Fungicides. National Bureau of Standards, Simplified Practice Recommendation R41–40; 5 cents.

Automobile Engine Lubricating Oils. National Bureau of Standards, Letter Circular 613; mimeographed.

Structural Properties of a Precast Joist Concrete Floor Construction. National Bureau of Standards, BMS Report 62; 10 cents.

Effects of Wetting and Drying on the Permeability of Masonry Walls, by Cyrus C. Fishburn. National Bureau of Standards, BMS Report 55; 10 cents.

Roofing in the United States—Results of a Questionnaire, by Leo J. Waldron and Hubert R. Snoke. National Bureau of Standards, BMS Report 57; 10 cents.

Properties of Adhesives for Floor Coverings, by Percy A. Sigler and Robert I. Martens. National Bureau of Standards, BMS Report 59; 10 cents.

Plumbing Manual. Report of Subcommittee on Plumbing of the Central Housing Committee on Research, Design, and Construction. National Bureau of Standards, BMS Report 66; 20 cents.

Handbook of Federal Labor Legislation—Labor Standards on Government Contract Work and Work Financed by the United States. U. S. Department of Labor, Division of Labor Standards Bulletin No. 39, Part I; 35 cents.

Conserving Manpower in Defense Industries. U. S. Department of Labor, Division of Labor Standards, Special Bulletin No. 4; 5 cents.

General Statement as to the Method of Payment Under the Fair Labor Standards Act and the Application of Section 3 (m) Thereto. U. S. Department of Labor, Wage and Hour Division Interpretative Bulletin No. 3 (revised October 1940). Available only from Wage and Hour Division, U. S. Department of Labor, Washington, D. C.

Fifth Report of the National Munitions Control Board, for the Period January 1–June 30, 1940. House Document No. 876, 76th Congress, 3rd Session; 20 cents.

Census of Mineral Industries. The first two of this series of reports has just appeared, Manganese and Iron Ore. This series parallels but does not duplicate the Census of Manufactures. Available from Bureau of the Census, Washington, D. C.

Alcohol Statistics. The Bureau of Internal Revenue has recently issued reports giving statistical data for the fiscal year ended June 30, 1940 on the following: Alcohol; Fermented Malt Liquors and Cereal Beverages; and Wine. Available from Alcohol Tax Unit, Bureau of Internal Revenue, Washington, D. C.; mimeographed.

Industrial Corporation Reports. Three additional reports have been issued by the Federal Trade Commission in this series, as follows: Clay Products (Other Than Pottery) Manufacturing Corporations; Rayon and Allied Products Manufacturing Corporations; Paint and Varnish Manufacturing Corporations. Available from Federal Trade Commission, Washington, D. C.

Survey of American Listed Corporations. The Supplement for 1939 to Chemicals and Fertilizers brings up-to-date the data contained in Volume 1, Report No. 3 of the Survey of American Listed Corporations. Available from Securities and Exchange Commission, Washington, D. C.

Analysis of Miscellaneous Chemical Imports Through New York in 1939. U. S. Tariff Commission; mimeographed.

Mineral Data. Preliminary reports were issued during January by states giving estimates of the production in 1940 of the major minerals and metals. In addition commodity reports were prepared for five items with reference to smelter production of copper, lead, zinc, cadmium, and lead and zinc pigments. Mine production reports are being prepared for these same metals and for gold and silver, bauxite and iron. The several items are being issued by the Bureau of Mines in their M.M.S. reports. Requests should identify commodities or states of interest.

Matte Smelting of Manganese, by C. E. Wood, E. P. Barrett, and P. R. Porath. U. S. Bureau of Mines, Report of Investigations 3545; mimeographed.

Shrinkage of Coke, by H. S. Auvil, J. D. Davis, and J. T. McCartney. U. S. Bureau of Mines, Report of Investigations 3539; mimeographed.

House Movement Induced by Mechanical Agitation and Quarry Blasting, by J. R. Thoenen, S. L. Windes, and Andrew T. Ireland. U. S. Bureau of Mines, Report of Investigations 3542; mimeographed.

Grinding Pebbles and Tube-Mill Liners, by Robert W. Metcalf. U. S. Bureau of Mines, Information Circular 7139; mimeographed.

Analyses of Some Illinois Crude Oils, by H. M. Smith. U. S. Bureau of Mines, Report of Investigations 3532; mimeographed.

Use of Rock Dust in Bituminous-Coal Mines, 1930–38 (A Statistical Survey), by W. W. Adams. U. S. Bureau of Mines, Report of Investigations 3543; mimeographed.

Gas Explosions in Buildings: Their Cause and Prevention, by D. J. Parker and C. W. Owings. U. S. Bureau of Mines, Information Circular 7142; mimeographed.

Mines Bureau Reports. Each of the major divisions of the Bureau of Mines is making available to those interested in mimeographed form an annual report of its activities for the fiscal year 1940, which ended June 30. Among those having material of some chemical engineering interest are: Annual Report of Research and Technologic Work on Coal, by Arno C. Fieldner and W. E. Rice. Information Circular 7143; Annual Report of the Mining Division, by Charles F. Jackson. Report of Investigations

3536; Annual Report of the Explosives Division, by Wilbert J. Huff. Report of Investigations 3537; Annual Report of the Nonmetals Division, by Oliver C. Ralston and John E. Conley. Report of Investigations 3538.

New Transportation Rules. Recently there have been published in the Federal Register two new sets of carrier regulations affecting chemicals, explosives, and other articles. In the issue of January 7 are the new motor carrier regulations issued by the Interstate Commerce Commission. In the issues of January 11 and January 14 to 18, inclusive, are the new water carrier regulations issued by the Department of Commerce. These new regulations are in effect Parts 7 and 8 of the recent Interstate Commerce Commission volume "Regulations for Transportation of Explosives and Other Dangerous Articles, etc., Effective January 7, 1941." The price of the Federal Registers is 10 cents each; the I.C.C. volume is 40 cents.

Capital Requirements — A Study in Methods as Applied to the Iron and Steel Industry (Computed as of 1939). National Resources Planning Board; 20 cents.

The Budget of the United States Government for the Fiscal Year Ending June 30, 1942. This large volume contains the President's budget message to Congress as well as the detailed estimates of appropriations for the various government agencies; $2 (paper).

RECENT BOOKS and PAMPHLETS

Index to A.S.T.M. Standards including Tentative Standards. Published by American Society for Testing Materials, Philadelphia, Pa. The Society's specifications, methods of testing, recommended practices, definitions of terms, and charts and tables, revised as of December, 1940.

Ingot Brass and Bronze. Published by Non-Ferrous Ingot Metal Institute, Chicago, Ill. Price $5.00. This 8½x11 loose-leaf publication contains six sections which deal with such subjects as: The economy and utility of ingot brass and bronze; nomenclature and classification; data on each of the 23 NFIMI Standard Alloys; miscellaneous specifications; foundry practice; and foundry defects. The volume is a coordinated attempt to supply up-to-date, authentic and comprehensive technical data relating specifically to many important phases of the production and efficient utilization of high quality ingot brass and bronze. Supplemental material, including technical revisions is expected to be issued from time to time. This material will be available for two years to domestic purchasers of the Manual without additional cost.

Airplane Metal Work. Vol. 2, Airplane Sheet Metal Shop Practice. By Alex M. Robson. Published by D. Van Nostrand Co., New York, N. Y. 109 pages. Price $1.25. A well-illustrated textbook on aircraft sheet-metal shop practice. Contains much trade information and numerous "do's" and "don'ts" for working with aluminum.

Our World Trade, January-September, 1940. Published by Foreign Commerce Department, Chamber of Commerce of the United States, Washington, D. C. 19 pages. The 80th quarterly issue gives a comparison of the January-September 1940 import and export data with the comparable period of the year before for both imports and exports by commodities and by countries of origin or destination. The value and volume figures are detailed for the principal commodities, that is the 50 most important judged by either dollar value or poundage.

A.S.T.M. Specifications for Pipe and Piping Materials. Published by American Society for Testing Materials, Philadelphia, Pa. 147 pages. Price $1.25. A selection of 24 of the 40 A.S.T.M. specifications covering pipe and piping materials, particularly materials used in high-pressure and high-temperature services. The classification of austenite grain size in steels with two grain size charts is also included.

A. S. M. E. Mechanical Catalog and Directory, 1941 edition. Distributed by the American Society of Mechanical En-

gineers, New York, N. Y. 501 pages. Price $3. A profusely illustrated catalog describing machines, equipment and materials. Also included are a directory which gives a practically complete index to all American manufacturers, a listing of hundreds of trade names of equipment and materials to aid the busy engineer, and a 16-page insert listing A.S.M.E. publications.

The Recovery of Sulphur Dioxide from Dilute Waste Gases by Chemical Regeneration of the Absorbent. By *H. F. Johnstone* and *A. D. Singh*. Engineering Experiment Station Bulletin No. 324 published by the University of Illinois, Urbana, Ill. 140 pages. Describes a process for the recovery of sulphur dioxide from dilute gases which depends on regenerating the absorbing solution by treatment with zinc-oxide. The absorbed sulphur dioxide is thereby converted into insoluble zinc sulphite. After removal of the solids, the solvent is returned to a scrubber. The zinc sulphite is dried and calcined under moderate temperature conditions, yielding sulphur dioxide, water vapor and zinc oxide.

Directory of Association Members. Published by Association of Consulting Chemists and Chemical Engineers, Inc., New York, N. Y. 57 pages. Gratis. A series of one-page statements from each member, descriptive of his and his organization's qualifications, scope, functions and activities. Supplementary sections give list of members arranged alphabetically, geographically and by types of services performed.

Bibliography of Spectrochemical Analysis. Compiled by *D. M. Smith*. Published by British Non-Ferrous Metals Research Association, Euston St., London. 55 pages. Price 3 shillings. In this second edition, the references have been brought up to August, 1940, and number 510. Short, explanatory notes are given with most of the references, and an author's index is provided. The groupings of the references in sections obviate the necessity for a subject index.

Power Alcohol, History and Analysis. Published by Committee on Motor Fuels, American Petroleum Institute, Chicago, Ill. 58 pages. A study of a subject of long-standing interest to farmers, legislators and the petroleum industry. "The claim that technical advantages of alcohol-gasoline fuels justify their extra cost is not supported by the facts."

Guide to Library Facilities for National Defense. Edited by *Carl L. Cannon*. 235 pages. Price $1.25. Results of a survey conducted by the Joint Committee on Library Research Facilities for National Emergency. Arrangement of the main text of the survey is first by broad subjects with subheadings for divisions of the field. Under the subject heading the arrangement is by regions of the counry, in order to facilitate maximum use of resources easily available to widely distributed research workers. Following the text is a directory of all libraries participating in the survey, and a detailed index. The section on chemicals (the longest in the book) includes chemical engineering, chemical research, chemical warfare, chemistry and drugs.

Chemical Analysis of Aluminum, 2nd Edition. Published by Aluminum Research Laboratory, New Kensington, Pa. 120 pages. Price 50 cents. Makes available to others the methods standardized and developed by Aluminum Company of America for the analysis of aluminum in its own laboratories. This second edition includes revisions in the methods given in the first edition as well as new material.

Brazil 1939/40. Published by Ministry of Foreign Affairs, Rio de Janeiro, Brazil. 383 pages. The annual survey on economics, social and geographic conditions in this important South American country. Written in English.

Der Phosphatrostschutz. By *O. Macchia*. Published by Verlag Chemie, Berlin. 250 pages. Price RM 12. The book seems to be a complete and unbiased discussion of the phosphate rustproofing processes with full credit given to work done in America. There are many illustrations and 606 literature references.

Calcium Superphosphate and Compound Fertilisers. By *P. Parrish* and *A. Ogilvie*. A review of this book appeared in *Chem. & Met.*, May 1940. It is now available in this country from the Chemical Publishing Co., New York, N. Y. Price $14.

MANUFACTURERS' LATEST PUBLICATIONS

Publications listed here are available from the manufacturers themselves, without cost unless a price is specifically mentioned. To limit the circulation of their literature to responsible engineers, production men and industrial executives, manufacturers usually specify that requests be made on business letterhead.

Air Conditioning. Carrier Corp., Syracuse, N. Y.—Bulletin AC-140—42-page 25th Anniversary booklet, commemorating the founding of this company and tracing the history of air conditioning. Describes early work of Willis H. Carrier, tells about installations made at each interval in the period discussed, and traces development of the science and accomplishments which have been possible through its use.

Alloys. Monsanto Chemical Co., Phosphate Div., St. Louis, Mo.—Phosphorus-Iron Alloy Bulletin No. 4—20-page technical bulletin published by this company's Phosphate Division, dealing with the use of phosphorus in iron alloys, containing two articles disclosing results of experimental research, and presenting evidence of the value of phosphorus as an alloy element in steels for high temperature and high pressure service.

Balances. Roller-Smith Co., 1766 West Market St., Bethlehem, Pa.—Catalog 4540—8 pages on this company's precision balances for rapid and accurate weighing of small objects of approximately the same value, describing various types and accessories, and special balances for surface tension, weighing bulky materials, etc.

Blowers. Roots-Connersville Blower Corp., Connersville, Ind.—Form R-5341—6-page leaflet discussing use of positive displacement blowers in the manufacture of raw water ice. Shows installations, gives data on selection and performance.

Brazing Alloys. Handy & Harman, 82 Fulton St., New York, N. Y.—4-page folder on this company's low-temperature brazing alloys, Sil-Fos and Easy-Flo. Describes method of use and types of application.

Briquetting Press. Harry W. Dietert Co., 9330 Roselawn Ave., Detroit, Mich.—Leaflet describing a newly developed specimen briquetting press announced by this company. Used for compression into tablets of powdered and granular metallic and non-metallic materials for spectro-chemical analysis.

Cements. Pennsylvania Salt Mfg. Co., 1000 Widener Bldg., Philadelphia, Pa.—Booklet No. 5—8 pages on this company's Asplit and improved Causplit synthetic resin cements, describing the cements, preparation of the mortar, application and uses. Gives physical properties and important points on use.

Chemicals. American Cyanamid & Chemical Corp., 30 Rockefeller Plaza, New York, N. Y.—Leaflet 580—20 pages on this company's Deceresol wetting agents, describing various types, giving chemical and physical properties and wetting power, and discussing applications.

Chemicals. Atlas Powder Co., Wilmington, Del.—Publication CD-8—12-page book on Arlex, this company's commercial sorbitol solution for use in cosmetics and shaving creams. Gives properties, advantages and medical evidence. Also leaflet CD-11, announcing and describing this company's new Arlacel A and B for cosmetic preparations, giving properties and typical formulations.

Chemicals. Niacet Chemicals Corp., Niagara Falls, N. Y.—36-page general catalog on this company's line of chemicals, including acetic acid, various acetates and chemicals derived from acetic acid, with detailed information on specifications, containers, properties, uses and other information on all principal types. Includes useful information tables.

Coatings. Linings, Inc., 914 South Michigan Ave., Chicago, Ill.—20-page book on this company's abrasion-, acid-, alkali-, and corrosion-resistant coatings for tank linings and the protection of wood, concrete and metals. Company supplies a series of coatings for specified purposes which are said to operate on principles different from paints and to contain no ingredients used in paints. Records of long service under severe conditions are cited.

Combustion Control. A. W. Cash Co., Decatur, Ill.—Bulletin 300—12 pages on this company's automatic combustion controls for steam plant use, showing principles involved, illustrating and describing various unit controllers made by the company, and describing various typical boiler and control hook-ups for both coal-, and oil- or gas-fired installations.

Drying Lamps. Westinghouse Lamp Division, Bloomfield, N. J.—Booklet A-3817—12 pages on this company's radiant-heat drying lamps, describing principles of radiant heat drying, showing typical applications, discussing principles of application in water evaporation, paint drying and mass heating, and describing six sorts of lamps available from this company.

Electrical Equipment. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Bulletin B-6137—4-page leaflet giving detailed description of this company's rocking contact voltage regulator for use with direct current machines in such applications as paper mills, chemical plants and electroplating. The regulator is adapted to the control of such functions as speed, tension and current.

Electrical Equipment. General Electric Co., Schenectady, N. Y.—Publications as follows: GEA-978B, High-speed induction motors for direct connection, 125 hp. and larger; GEA-2234C, manual motor starting switches for fractional horsepower motors; GEA-2599, 24 pages on advantages of FH cubicles for isolation and insulation of electrical equipment; GEA-3469, new pushbutton stations; GEA-3488, 8 pages on maintenance of dc. motors.

Electrical Equipment. Roller-Smith Co., 1766 West Market St., Bethlehem, Pa.—Catalogs 3650 and 3940—Respectively 8 and 4 pages, covering oil circuit breakers for outdoor and underground use, giving construction information, application and dimension information.

Equipment. American Brake Shoe & Foundry Co., 230 Park Ave., New York, N. Y.—36-page booklet briefly describing the products of this company, its several divisions and its various subsidiaries. Covers alloy castings, heat-resisting alloys, friction materials, antifrictional materials, forgings, miscellaneous castings, railroad and automotive service equipment.

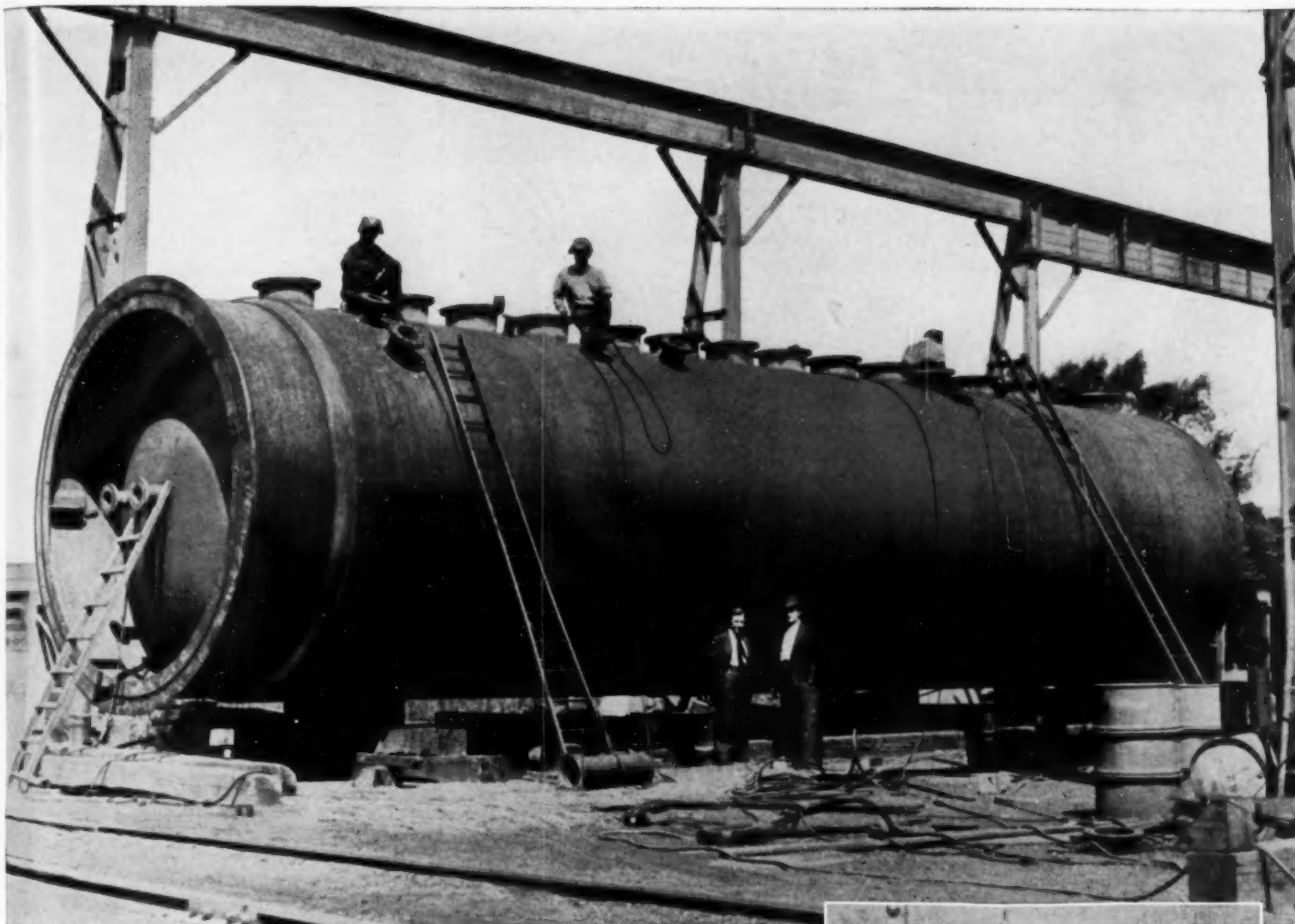
Equipment. Carrier Corp., Syracuse, N. Y.—Catalog AC 139—44 pages entitled "20 Years of Centrifugal Refrigeration," describing principles of the method, details of construction, operating characteristics, advantages, performance, uses, refrigerant characteristics, specifications. Gives details on numerous installations. Also 4-page price and data sheet on this company's new propeller-fan-type unit heaters, giving description and engineering data.

Equipment. Farrel-Birmingham Co., Ansonia, Conn.—Bulletin 11-R-406—4-pages of news on this company's equipment, discussing economics of modernization of a rubber plant, and describing a new tilted refiner for use in rubber reclaiming.

Equipment. Hassell Engineering Co., Colorado Springs, Colo.—Catalog G-4100—16 pages, with prices, on new and used equipment available from this company, covering such types as agitators, grinding mills, classifiers, crushers, filters, flotation machines, jigs, motors, pumps, tables, tanks and thickeners.

Equipment. International Engineering, Inc., Dayton, Ohio—Catalog 71—20 pages on this company's blowers and fans, covering axial and duct types, man-coolers, ventilating fans and accessories; also Catalog 85, 10 pages on ball and pebble mills with information on specifications and capacities.

Flakers. Buffalo Foundry & Machine Co., Buffalo, N. Y.—Bulletin 326—12 pages on this company's flakers for cooling and flaking chemicals, describing construction, suitable cooling media, typical details, various types, and typical applications.



Furnaces. Baker & Co., Inc., 113 Astor St., Newark, N. J.—11-page booklet on high temperature furnaces with platinum resistors as heating units. Gives physical and electrical properties of platinum and various of its alloys, describes furnace construction, and gives information for calculation of resistor size. Discusses control, life of resistors and other pertinent information.

Heaters. B. F. Sturtevant Co., Hyde Park, Boston, Mass.—Catalog 454—16 pages on a new down-blast unit heater for industrial use, with information on construction, installation and numerous tables to facilitate selection.

Instruments. The Brown Instrument Co., Philadelphia, Pa.—Catalog 1104—36 pages on this company's indicating, recording and controlling potentiometer pyrometers of electric and air-operated types, with detailed information on construction and special features, various types, and accessories available. Describes also this company's Radiamatic radiation pyrometer and illustrates typical methods of thermocouple installation.

Instruments. Herman H. Sticht Co., 27 Park Place, New York, N. Y.—Bulletin 750—4 pages describing this company's new Standco universal type hand tachometer of the direct-reading centrifugal type, available in four standard range combinations, covering speeds between 30 and 48,000 r.p.m.

Ladders. Aluminum Ladder Co., Tarentum, Pa.—Catalog 4—42 pages on this company's aluminum ladders, gangways, stages, scaffolding, conveyors and special aluminum equipment for industrial, commercial and fire-fighting use. Gives information on strength, durability and utility.

Magnetic Separation. Stearns Magnetic Mfg. Co., Milwaukee, Wis.—Bulletin 92-C—Describes this company's line of automatic safety-trap spout magnets, giving descriptive data, specifications, illustrations and installation drawings.

Materials Handling. Cleveland Tramrail Div., The Cleveland Crane & Engineering Co., Wickliffe, Ohio—Form 2006-A—4 pages describing this company's new raise-lower cab carrier for use on overhead tramrail materials handling systems, illustrating how this new system is being applied to the handling of several types of material, with greater safety, speeding of handling, and economy of labor.

Materials Handling. The B. F. Goodrich Co., Akron, Ohio—12-page booklet on this company's cord conveyor belts, describing advantages of this construction, recommended service conditions, method of estimating number of plys needed under different operating conditions, and other pertinent points in belt conveyor operation.

Materials Handling. Reading Chain & Block Corp., Reading, Pa.—Bulletin 1004—12 pages on electric hoists, giving construction details on this company's products, showing typical applications, and giving specifications and dimension information.

Materials Handling. Robbins Conveying Belt Co., Passaic, N. J.—Bulletin 112—4 pages with description and engineering data on this company's Robbins-Oro manganese steel apron feeders for heavy-duty feeding of minerals and abrasive materials.

Meters. American District Steam Co., North Tonawanda, N. Y.—Folder 140—4 pages giving detailed description of principles of this company's recently developed orifice type flowmeter for steam, water, air and gas.

Mixing. Hendrick Mfg. Co., Carbondale, Pa.—20-page book on this company's equipment for mixing of various combinations of gases, liquids and solids. Describes performance of specific installations of this company's equipment, the importance of kettle design and various types of mixer made by the company. Gives condensed data on shaft design for liquid mixing units.

Motors. Century Electric Co., St. Louis, Mo.—Bulletin BC A120—Four pages on this company's totally inclosed, fan-cooled, squirrel-cage motors, describing construction details and showing various methods of mounting.

Pneumatic Tools. Independent Pneumatic Tool Co., 600 West Jackson Blvd., Chicago, Ill.—Pneumatic Tool Catalog No. 52—Describes eight new pneumatic tools made by this company, including

right-angle and close-corner drills, right-angle nut-setters and screw drivers, bolt wrenches, grinders, chipping hammers, sanders and saws.

Power Transmission. D. O. James Mfg. Co., 1120 West Monroe St., Chicago, Ill.—4-page leaflet illustrating and briefly describing three classifications of motorized speed reducers manufactured by this company.

Power Transmission. Link-Belt Co., 307 North Michigan Ave., Chicago, Ill. —Folder 1894—4 pages describing this company's 3/16-in.-pitch Silverstreak silent chain drive for fractional horsepower duty on small machinery.

Pumps. Goulds Pumps, Inc., Seneca Falls, N. Y.—New industrial catalog on pumping equipment for power plants and industrial process work, containing bulletins on various types of pumps, including centrifugal, reciprocating and rotary pumps, sump pumps, condensate return units and miscellaneous units.

Refractories. Illinois Clay Products Co., Joliet, Ill.—2-page leaflet on this company's Therm-O-Flake insulating brick made from exfoliated vermiculite; describes characteristics, thermal conductivity, advantages and applications.

Shaft Seals. Fulton Sylphon Co., Knoxville, Tenn.—Engineering Bulletin 825—20 pages on this company's shaft seals, showing many types designed to prevent leakage of gas or liquid around rotating shafts, for pressures up to 200 lb. and shaft sizes above ½ in. Gives specifications, dimensions, operating characteristics, instructions for ordering and other useful information for designers.

Sliding Grilles. Cornell Iron Works, 36th Ave. and 13th St., Long Island City, N. Y.—Catalog SG3—8 pages on this company's sliding grilles for closures of doors and other openings, showing typical applications, giving specifications and showing installation details.

Speed Control. Reeves Pulley Co., Columbus, Ind.—Form G-412—24 pages on speeding up of production with variable speed control, citing 36 specific examples in numerous types of industrial plants in which speed control improved production rate. Also describes three basic types of variable speed equipment made by this company. Also Form G-407, a 6-page folder compressing the maximum of information on variable speed drives into a minimum of space.

Steels. Allegheny Ludlum Steel Corp., Pittsburgh, Pa.—Bulletin TC1, Edition 1—122-page book on this company's special steels, with information on properties, uses and fabricators, covering such materials as stainless steels, carbon steels, Nitralloy steels, tool steels and special products. Gives complete information on properties and applications.

Tools. Ampco Metal, Inc., Milwaukee, Wis.—8-page folder describing this company's safety tools produced of non-sparking Ampco metal and beryllium copper, illustrating types of wrenches, scrapers, hammers, axes, spatulas and knives produced, and discussing advantages.

Valves. The B. F. Goodrich Co., Akron, Ohio—Catalog Section 9787—2-page booklet on this company's Vulcalock rubber-lined valves, giving complete directions for installation and care, and detailed description of suitable services.

Water Treatment. Activator Process Sales Co., 501 South Merengo Ave., Alhambra, Calif.—Bulletin 12—4-page folder giving engineering specifications on this company's Activator process for feedwater treatment, showing typical flowsheets, describing equipment and performance, and discussing advantages. Also three-page supplementary bulletin, giving case histories of three large industrial installations.

Water Treatment. Proportioneers, Inc., Providence, R. I.—Technical Bulletin 1000. 20—6-page bulletin discussing the use of the chloramine process for keeping heat exchangers clean, describing the process, and equipment available for its application. Shows typical layout diagrams.

Welding. Air Reduction, 60 East 42d St., New York, N. Y.—Form ADG-1081W —16 pages on the use of arc welding in building construction, describing advantages, fundamentals of design for welded construction, construction of a typical building, and this company's welding machines and electrodes.

LOUISVILLE DRYER SAVES $14,850 ANNUALLY— INCREASES OUTPUT 50%!

If you are thinking of installing a new drying process, or of replacing an existing, out-dated dryer, we'd like you to ask us one question: *"Can a Louisville Dryer reduce our drying costs?"*

Our answer will not be given until we know the facts, but the chances are it will be an emphatic "Yes!" In one such case ("blue-printed" at the right), the manufacturer's old dryer was turning out 6,000 tons per year at a cost of $3.72 a ton. Louisville engineers began experiments, soon assured the manufacturer that a Louisville Dryer, costing *half* as much as ...ld dryer, would not only cut his drying cost 77.6%, but would also *increase output* 50%! Result: the Louisville Dryer was installed, released 1,000 square feet of floor space, paid for itself in the first nine months and has since saved its owner $14,8... every year!

FORMER DRYER	
Installed cost	$40,000
Annual production (tons)	6,000
Drying cost per ton (Space required, 1500 sq. ft.)	$3.72
LOUISVILLE DRYER	
Installed cost	$20,000
Annual production (tons)	9,000
Drying cost per ton (Space required, 500 sq. ft.)	$0.83
YEARLY SAVINGS OF LOUISVILLE DRYER, IN OPERATING COSTS ALONE	$14,850

Can similar economies be made ... your drying operations? It's al... gether possible — and Louisville e... neers will be glad to tell you wit... cost. A note from you will sta... working on your problem. *Add...* Louisville Drying Machinery ... pany, *Incorporated*, 451 Baxter A... Louisville, Kentucky.

Chem & Met ECONOMICS and MARKETS

NEW RECORDS FORECAST FOR 1941 IN PRODUCTION AND CONSUMPTION OF CHEMICALS

THERE appeared to be but little change in the rate of manufacturing activities in January from what had been reported for December. In a few instances, petroleum refining for example, there was a dropping off from the December level. Steel mills, textiles, and other industries, however, moved at an accelerated rate and the net change was in favor of higher consumption of chemicals and other raw materials. The preliminary index for consumption of chemicals in January is 153 which compared with 150.05 for December and with 144.85 for January last year.

Last year there were indications in February that some of the manufacturing lines were becoming cautious and outputs in the next few months were on a descending scale. The present situation points to a reversal in procedure with a rising line forecast for production.

Chem. & Met.'s Weighted Index for Chemical Consumption

	November revised	December
Fertilizer	30.96	31.80
Pulp and paper	20.20	21.00
Petroleum refining	13.80	14.27
Glass	13.75	13.83
Paint and varnish	10.37	9.20
Iron and steel	12.25	12.30
Rayon	12.46	12.67
Textiles	9.57	9.86
Coal products	9.37	9.60
Leather	4.22	4.15
Explosives	5.03	4.88
Rubber	3.20	3.32
Plastics	3.00	3.17
	148.18	150.05

The fertilizer trade is less affected by defense measures than are other lines but with agricultural income advanced, a moderate gain over last year is anticipated. Seasonal influences bring about rather sharp fluctuations in the month-by-month output of superphosphate but the annual totals reflect this in a smaller degree and the same should hold true for the current season.

Trade opinions have generally held that textile mills would be active in the first half of the year with some uncertainty about later months. Now there is a tendency to revise earlier opinions upward and where estimates of an 8,500,000 bale cotton-consumption were heard, the probability of requirements reaching 9,000,000 bales are now heard. Silk manufacture exceeded expectations in January with mills taking 28,425 bales. Woolen mills have a large backlog of orders and all in all the textile situation may be declared promising.

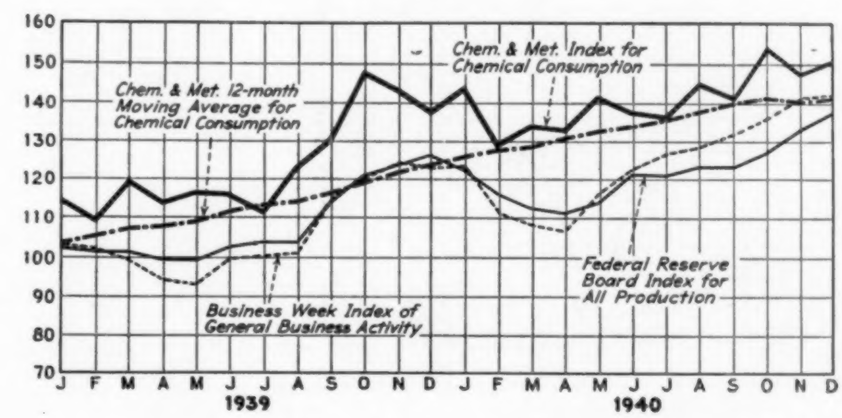
Steel plants not only pushed outputs in January but must continue to do so if requirements are to be met and, as capacities are being extended, there is good reason to believe that production will be of record proportions in the present year. Pulp mills are confronted with a position where domestic demand has increased, imports have declined, and exports have gained to a marked degree. Exports of pulp wood last year amounted to 481,375 tons compared with 139,504 tons in 1939.

Rayon yarn is finding a much better consuming market each year and the rise in staple production last year will be accentuated this year with new facilities coming into operation and with its use becoming more diversified. While petroleum refining was reduced somewhat in January, requirements for petroleum products for the year are placed at 6 percent over those of last year and in some quarters the probable increase is estimated as high as 10 percent.

Sales of paint and varnish last year were rather disappointing in view of the rise in general business. Automotive production got off to a good start with an unusually large number of units turned out in January. Building schedules, in progress and in prospect, should work in favor on a wider use of paint materials in the coming months.

When the large powder plants now under construction, begin to operate, a new consuming industry of importance will be added to those now responsible for the ultimate disappearance of chemicals and while demand from this quarter will be largely concentrated in a few materials, it will exert considerable influence upon the volume of chemical output.

Reviewing the industries which influence the volume of chemical production, leads to the conclusion that consuming demand will be larger than ever before. It is further apparent that demand for certain selections will be abnormally heavy and it is significant that the question of priorities has now been extended to the chemical industry which infers that defense requirements may limit the amounts available for some of the ordinary industrial needs. Added to the increase in domestic demands, the problem of supplying a greatly enlarged export market must be met.

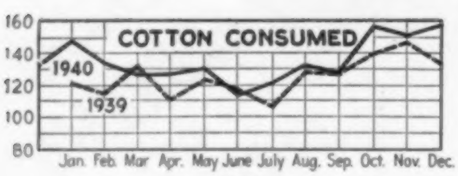


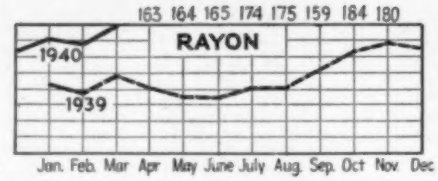
Production and Consumption Data for Chemical-Consuming Industries

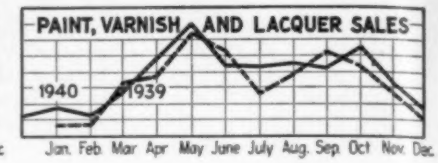
Production	December 1940	December 1939	Jan.-Dec. 1940	Jan.-Dec. 1939	Per cent of gain for 1940
Alcohol, ethyl, 1,000 pr. gal	23,762	22,080	263,181	221,629	18.7
Alcohol denatured, 1,000 wi. gal	12,215	11,145	134,223	115,904	15.7
Ammonia, liquor, 1,000 lb	5,310	4,903	56,646	48,264	17.4
Ammonium sulphate, tons	64,382	60,636	717,192	580,274	23.6
Benzol, 1,000 gal	12,528	11,811	132,745	104,913	26.5
Byproduct coke, 1,000 tons	4,890	4,703	53,860	42,882	25.6
Naphthalene, 1,000 lb	7,212	5,315	....	48,460	....
Toluol, 1,000 gal	2,439	2,168	....	19,767	....
Glass containers, 1,000 gr	4,203	4,046	54,264	51,227	5.9
Plate glass, 1,000 sq. ft	17,491	18,477	164,371	141,741	15.9
Window glass, 1,000 boxes	1,458	1,189	13,678	10,777	27.0
Methanol, crude, 1,000 gal	484	434	5,294	4,660	13.6
Methanol, syn., 1,000 gal	3,913	4,184	44,968	34,256	31.3
Rubber reclaimed, tons	19,297	18,009	209,601	190,158	10.2
Consumption					
Cotton, bales	775,472	650,123	8,007,889	7,368,848	8.7
Silk, bales	23,113	21,128	312,867	383,431	18.4*
Wool, 1,000 lb	42,498	30,043	407,003	396,313	2.7
Explosives, 1,000 lb	33,461	30,580	406,671	372,471	9.2
Paint and varnish, sales, $1,000	28,308	26,810	412,516	394,508	4.6

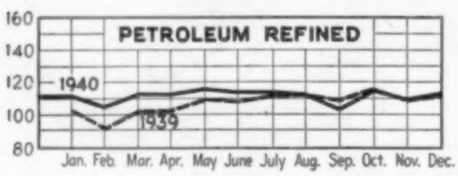
* Per cent of decrease.

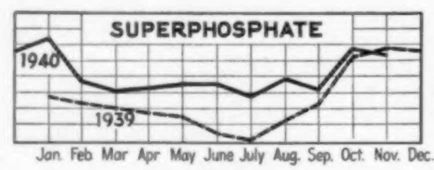
Production and Consumption Trends

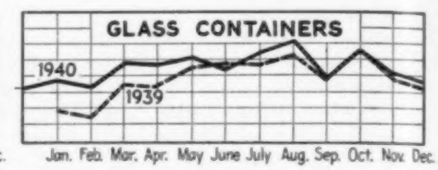


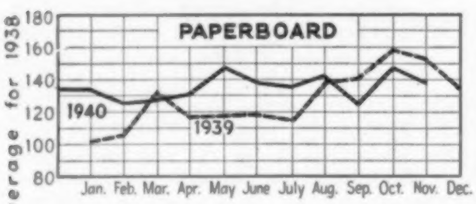


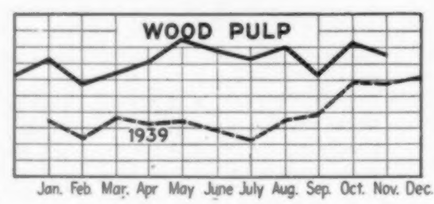


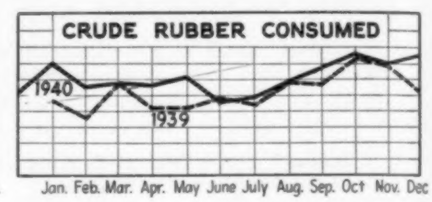


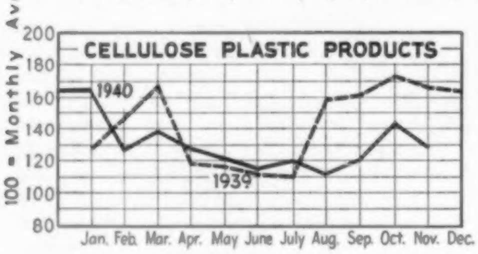


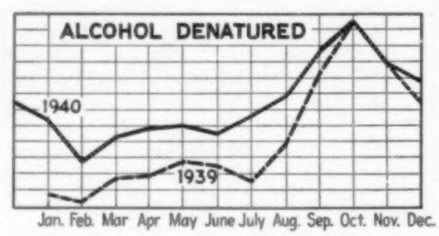


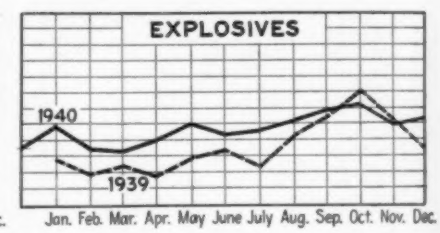


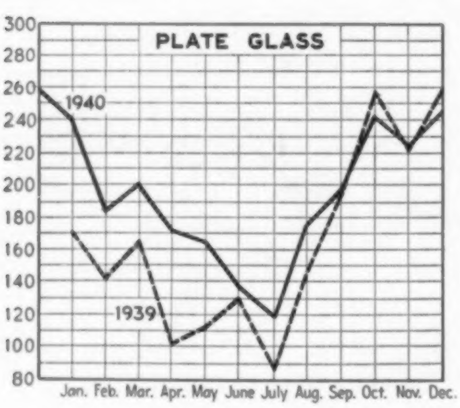


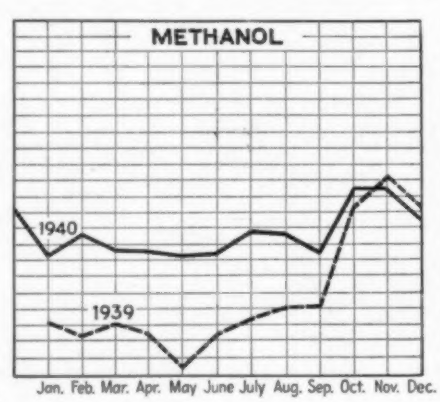


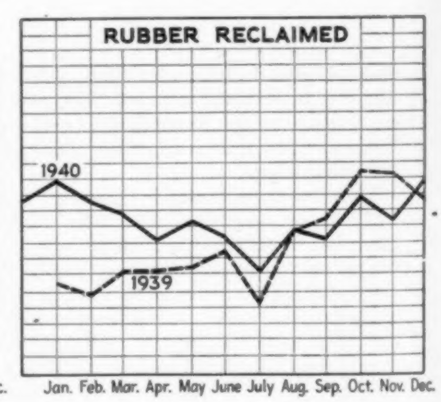


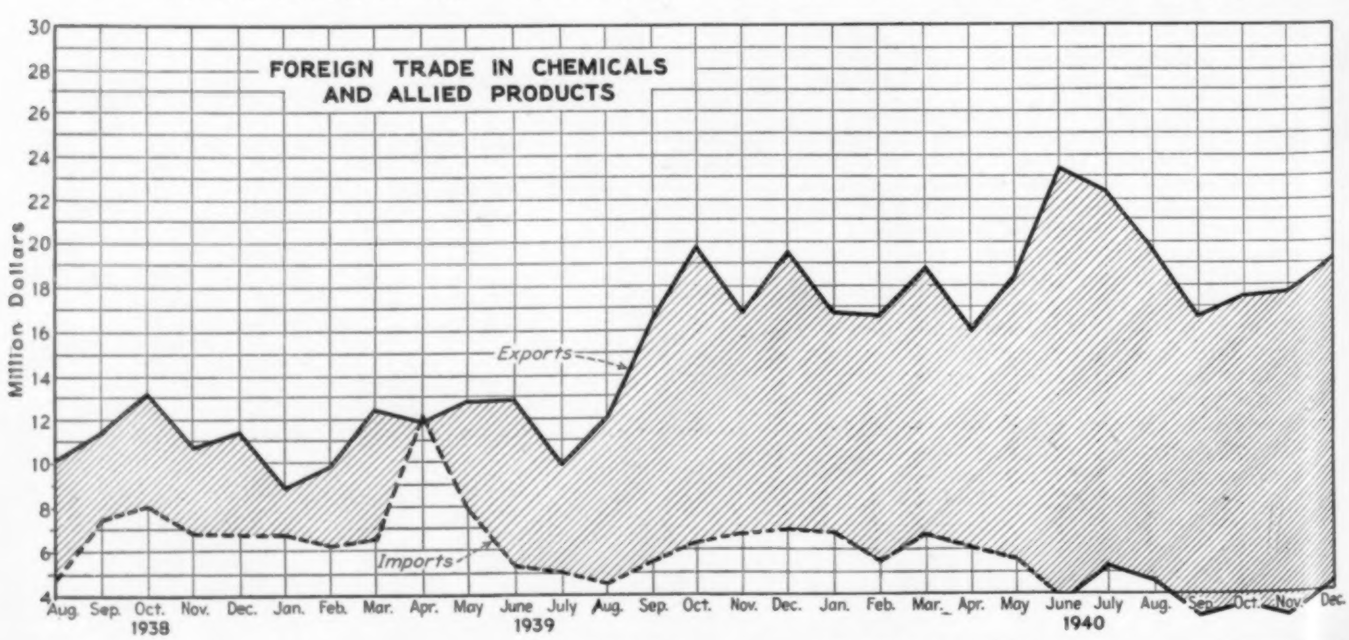












A policeman never knows what dangers may be lurking in the shadows of his beat. He accepts peril, risks his life, takes chances as his duty.

Dangers lurk, too, in the path of every product that is shipped in drums. Dangers that may imperil a fine product and a cherished reputation. Yet no chances need be taken. Shipments can be made with safety, with confidence, with no risk to a single drop —in Tri-Sure-equipped drums.

Tri-Sure Closures eliminate all the hazards a shipment can face—tampering, pilferage, substitution, leakage and waste—because the Tri-Sure seal cannot be removed unless it is deliberately destroyed, the Tri-Sure plug is always held tightly in place, the Tri-Sure flange assures complete drainage.

Don't take chances with your next shipment. You don't have to. Ship the *sure* way —the Tri-Sure way—and protect your product, your reputation and your customers. Write for information on Tri-Sure Closures.

Tri-Sure

Reg. U. S. Pat. Off.

CLOSURES

AMERICAN FLANGE & MANUFACTURING CO., INC.
30 Rockefeller Plaza, New York

ACTIVE CALL FOR CONTRACT DELIVERIES RESULTS IN LARGE MOVEMENT OF CHEMICALS

As most consumers of heavy chemicals are covered ahead on first quarter requirements, the greater part of recent activity has been connected with shipping instructions for contract deliveries. The movement in January was reported to have been large and well above the level for the corresponding month of last year. In the current month there has been no slackening in call for deliveries. In February last year, there were indications that some of the consuming branches were not holding the January rate of operation and this trend became more in evidence in the next few months. This year, no slowing up in production schedules has been apparent and the trend is expected to be upward a little later when new plant capacities begin to function. While the defense program has been important, its influence so far has been more in the way of stimulating regular industrial operations rather than by creating direct demand for chemicals in the munitions field.

In the spot market, there has been considerable interest in chemicals but most of it is centered in selections which are scarce and on which prices are a matter of negotiation. This is not a new situation as it has existed for more than a year. During that period, sales of some of the potash salts have been made at price levels which are reminiscent of the market at the time of the first world war. It has been impossible to quote any reliable price for such items as caustic and chlorate of potash. Tataric acid later came into this classification and high prices entered into some transactions in cobalt oxide. Export prices for copper sulphate and sulphate of ammonia have been nominal at times because of the sold up position of the market. The greater part of production of these chemicals, however, has been disposed of at contract prices and the relatively small amounts which passed through the spot market should not be regarded as indicative of the real sales prices. It is noted that in the last week of January, a French ship arrived in port having on board small supplies of two of the chemicals which are scarce, namely red arsenic and chlorate of potash.

With prices for first quarter delivery well established, there is little to report regarding price developments in the last month. The undertone is firm and any adjustments which may be made for later shipments are more likely to be up than down although many of the important chemicals will probably be offered at existing levels. On imported chemicals, the freight situation is not promising as different reports are current relative to the probability of increased cargo rates.

Some of the vegetable oils have not held recent price advances but others have advanced and the market for animal fats is fairly steady so the price trend for the group has continued upward. Heavy stocks of lard are a threat to price stability and cottonseed oil is proving rather sensitive to changes in values for lard. Linseed oil has been moving freely and appears to be in a strong position as the supply of domestic seed is said to be quite small and the official estimate for the Argentine crop has reduced the total to less than 62,000,000 bu. which is a marked drop from earlier estimates.

There has been but little change in the China wood oil situation over a long period and the use of competing oils has gained steadily. The fact that offerings of perilla oil also have been restricted has further complicated the market for drying oils. The possibility for future perilla supplies may be inferred from a report from Manchuria which states that the first official estimate places the 1940 Manchuria perilla seed crop at 47,000 metric tons, but the trade estimates it at about 45,000 tons. Production in recent years has steadily declined, despite the 5-year program for increased output. Production estimates by the Ministry of Industry, in metric tons, have been as follows: 1935, 181,000 tons; 1936, 147,000; 1937, 106,000; 1938, 116,000; 1939, 70,000 tons. In normal years practically the entire crop was shipped to Dairen, where it was exported in the form of seed, or of oil and cake produced by Dairen mills. In 1939 only a minor proportion of the crop arrived there, and the disposition of the rest totaling between 30,000 and 50,000 tons is not ascertainable.

Assuming the 1940 perilla-seed crop at 45,000 tons, and the normal proportion of 40 percent retained for crushing in Manchuria, this year's production is estimated at 6,000 metric tons of oil and 12,000 tons of cake. Milling started in December and the entire production will be handled by two Dairen oil mills.

CHEM. & MET.

Weighted Index of

CHEMICAL PRICES

Base = 100 for 1937

This month	**99.98**
Last month	100.00
February, 1940	98.96
February, 1939	98.27

Price changes were infrequent and contract deliveries are going forward at previously established levels. Turpentine showed a net loss. Spot trading in a few chemicals which are scarce, is conducted at private terms.

Sales of paint, varnish, and lacquer last year were reported at $412,515,812 which represented only a moderate gain over the total of $394,508,431 as reported for the preceding year. Sales of lacquer for the year were placed at 47,969,129 gal. compared with 42,782,431 gal. in 1939, which indicates that lacquers made a relatively much better showing.

Export trade in chemicals and related products moved upward in December with shipments valued at $19,200,000 which exceed those for November and also those for December, 1939. The December movement brought the total for the year to approximately $221,900,000 compared with $162,800,000 for 1939 or a gain of more than 36 percent for the year. Imports of chemicals and related products in December were valued at $4,400,000 making a total of $58,300,000 for the year or a decrease of more than 26 percent for the period.

Reports regarding domestic production of materials last year are coming from the Bureau of Mines. For instance, the output of bauxite is given at 438,000 long tons and was valued at $2,573,000 an increase of 17 percent in quantity and 19 percent in value as compared with the 1939 figures. All the increase in production was accounted for by mines in Arkansas, shipments from Alabama and Georgia having again declined. For the first time Virginia was listed among the producing states. The cadmium content of compounds was estimated at 785,000 lb. or 16 percent over 1939 totals.

Prospects for an improvement in export trade in rosin with the United Kingdom do not appear bright in view of a report that the Board of Trade has reduced the turpentine and rosin import quotas for the first quarter of 1941. Rosin imports under the quota for the period will total 4,800 long tons monthly, of which 4,000 long tons will be purchased from Portugal. The Board of Trade also has advised that the turpentine import quota was fixed in practice beginning Oct. 1, 1940, at 1,500 tons monthly, of which 500 were to come from Portugal. The quota which was allowed to come from other countries has now been reduced to 800 tons for the first quarter of 1941.

CHEM. & MET.

Weighted Index of Prices for

OILS & FATS

Base=100 for 1937

This month	**75.45**
Last month	75.26
February, 1940	82.40
February, 1939	67.71

The price trend continued upward but some important selections, notably crude cottonseed oil, fell off from their high points. Animal fats showed very little net change.

INDUSTRIAL CHEMICALS

	Current Price	Last Month	Last Year
Acetone, drums, lb	$0.07½–$0.08	$0.07½–$0.08	$0.07¼–$0.07½
Acid, acetic, 28%, bbl., cwt	2.23 – 2.48	2.23 – 2.48	2.23 – 2.48
Glacial 99%, drums	8.43 – 8.68	8.43 – 8.68	8.43 – 8.68
U. S. P. Reagent	10.25 –10.50	10.25 –10.50	10.25 –10.50
Boric, bbl., ton	106.00–111.00	106.00–111.00	106.00–111.00
Citric, kegs, lb	.20 – .23	.20 – .23	.20 – .23
Formic, cbys., lb	.10½– .11	.10½– .11	.10½– .11
Gallic, tech., bbl., lb	.90 – 1.00	.90 – 1.00	.70 – .75
Hydrofluoric 30% drums, lb	.08 – .08½	.08 – .08½	.07 – .07½
Lactic, 44%, tech., light, bbl., lb	.06½– .06¾	.06½– .06¾	.06½– .06¾
Muriatic, 18°, tanks, cwt	1.05 –......	1.05 –......	1.05 –......
Nitric, 36°, carboys, lb	.05 – .05½	.05 – .05½	.05 – .05½
Oleum, tanks, wks., ton	18.50 –20.00	18.50 –......	18.50 –20.00
Oxalic, crystals, bbl., lb	.10¾– .12	.10¾– .12	.10¾– .12
Phosphoric, tech, c'bys., lb	.07½– .08½	.07½– .08½	.07½– .08½
Sulphuric, 60°, tanks, ton	13.00 –......	13.00 –......	13.00 –......
Sulphuric, 66°, tanks, ton	16.50 –......	16.50 –......	16.50 –......
Tannic, tech, bbl., lb	.54 – .56	.54 – .56	.40 – .45
Tartaric, powd., bbl., lb	.50 –......	.43¼–......	.31¼–......
Tungstic, bbl., lb	nom......	nom......	nom......
Alcohol, amyl	......–......	......–......	......–......
From Pentane, tanks, lb	.111–......	.111–......	.101–......
Alcohol, Butyl, tanks, lb	.09 –......	.09 –......	.09 –......
Alcohol, Ethyl, 190 p'f., bbl., gal	6.04 –......	6.04 –......	4.54 –......
Denatured, 190 proof	......–......	......–......	......–......
No. 1 special, bbl., gal. wks	.31½–......	.31½–......	.29½–......
Alum, ammonia, lump, bbl., lb	.03½– .04	.03½– .04	.03½– .04
Potash, lump, bbl., lb	.03¾– .04	.03¾– .04	.03¾– .04
Aluminum sulphate, com. bags, cwt	1.15 – 1.40	1.15 – 1.40	1.15 – 1.40
Iron free, bg., cwt	1.60 – 1.70	1.60 – 1.70	1.30 – 1.55
Aqua ammonia, 26°, drums, lb	.02¼– .03	.02¼– .03	.02 – .03
tanks, lb	.02 – .02¼	.02 – .02¼	.02 – .02¼
Ammonia, anhydrous, cyl., lb	.16 –......	.16 –......	.16 – .16
tanks, lb	.04½–......	.04½–......	.04½–......
Ammonium carbonate, powd. tech., casks, lb	.09 – .12	.09 – .12	.09 – .12
Sulphate, wks., cwt	1.45 –......	1.45 –......	1.40 –......
Amylacetate tech., from pentane, tanks, lb	.10½–......	.10½–......	.10½– .10½
Antimony Oxide, bbl., lb	.12 –......	.13 –......	nom. ......
Arsenic, white, powd., bbl., lb	.03½– .04	.03½– .04	.03 – .03½
Red, powd., kegs, lb	.17 – .18	.17 – .18	.15¾– .16
Barium carbonate, bbl., ton	52.50 –57.50	52.50 –57.50	52.50 –57.50
Chloride, bbl., ton	79.00 –81.00	79.00 –81.00	79.00 –81.00
Nitrate, casks, lb	.08½– .10	.08½– .10	.07 – .08
Blanc fixe, dry, bbl., lb	.03½– .04	.03½– .04	.03½– .04
Bleaching powder, f.o.b., wks., drums, cwt	2.00 – 2.10	2.00 – 2.10	2.00 – 2.10
Borax, gran., bags, ton	43.00 –......	43.00 –......	48.00 –51.00
Bromine, cs., lb	.30 – .32	.30 – .32	.30 – .32
Calcium acetate, bags	1.90 –......	1.90 –......	1.90 –......
Arsenate, dr., lb	.06½– .06¾	.06½– .06¾	.06¾– .07
Carbide drums, lb	.04¾– .05	.04¾– .05	.05 – .06
Chloride, fused, dr., del., ton	19.00 –24.50	19.00 –24.50	21.50 –24.50
flake, dr., del., ton	20.50 –25.00	20.50 –25.00	23.60 –25.00
Phosphate, bbl., lb	.07½– .08	.07½– .08	.07½– .08
Carbon bisulphide, drums, lb	.05 – .06	.05 – .06	.05 – .06
Tetrachloride drums, lb	.04¾– .05½	.04¾– .05½	.04¾– .05½
Chlorine, liquid, tanks, wks., lb	1.75 –......	1.75 –......	1.75 –......
Cylinders	.05½– .06	.05½– .06	.05½– .06
Cobalt oxide, cans, lb	1.84 – 1.87	1.84 – 1.87	1.84 – 1.87
Copperas, bgs., f.o.b. wks, ton	18.00 –19.00	18.00 –19.00	17.00 –18.00
Copper carbonate, bbl., lb	.10 – .16½	.10 – .16½	.10 – .16
Sulphate, bbl., cwt	4.75 – 5.00	4.75 – 5.00	4.75 – 5.00
Cream of tartar, bbl., lb	.43¼–......	.43¼–......	.28¾–......
Diethylene glycol, dr., lb	.22 – .23	.22 – .23	.22 – .23
Epsom salt, dom.,tech., bbl., cwt	1.80 – 2.00	1.80 – 2.00	1.80 – 2.00
Ethyl acetate, drums, lb	.07½–......	.07½–......	.06½–......
Formaldehyde, 40%, bbl., lb	.05½– .06	.05½– .06¼	.05¾– .06½
Furfural, tanks, lb	.09 –......	.09 –......	.09 –......
Fusel oil, drums, lb	.16 – .17	.16 – .17	.16 – .17
Glaubers, salt, bags, cwt	.95 – 1.00	.95 – 1.00	.95 – 1.00
Glycerine, c.p., drums, extra, lb	.12½–......	.12½–......	.12½–......
Lead:			
White, basic carbonate, dry casks, lb	.07½–......	.07½–......	.07 –......
White, basic sulphate, sck., lb	.07¼–......	.07¼–......	.06½–......
Red, dry, sck., lb	.08 –......	.08 –......	.07½–......
Lead acetate, white crys, bbl., lb	.11 – .12	.11 – .12	.11 – .12
Lead arsenate, powd., bag, lb	.09½– .11	.09½– .11	.10 – .10½
Lime, chem., bulk, ton	8.50 –......	8.50 –......	8.50 –......
Litharge, pwd., csk., lb	.07 –......	.07 –......	.06½–......
Lithophone, bags, lb	.0385 .04	.0385 .04	.036– .04
Magnesium carb., tech., bags, lb	.06½– .06½	.06½– .06½	.06 – .06½

The accompanying prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to Feb. 13

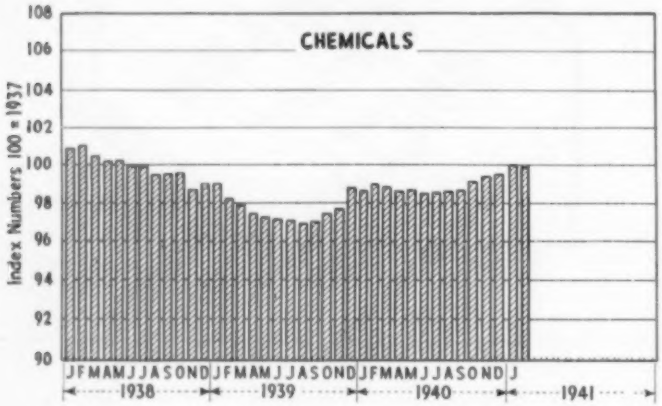
Chem & Met Current PRICES

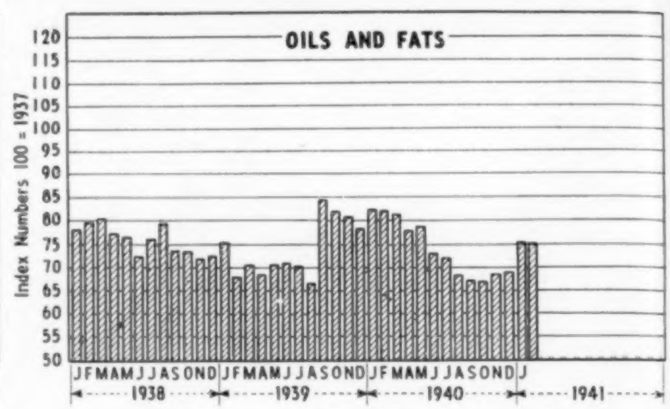
	Current Price	Last Month	Last Year
Methanol, 95%, tanks, gal	.29 –......	.29 –......	.31 –......
97%, tanks, gal	.30 –......	.30 –......	.32 –......
Synthetic, tanks, gal	.30 –......	.30 –......	.33 –......
Nickel salt, double, bbl., lb	.13 – .13½	.13 – .13½	.13 – .13½
Orange mineral, csk., lb	.11 –......	.11 –......	.10½–......
Phosphorus, red, cases, lb	.40 – .42	.40 – .42	.40 – .42
Yellow, cases, lb	.18 – .25	.18 – .25	.18 – .25
Potassium bichromate, casks, lb	.08¾– .09	.08¾– .09	.08¾– .09
Carbonate, 80–85%, calc. csk., lb	.06½– .07	.06½– .07	.06½– .07
Chlorate, powd., lb	.10 – .12	.10 – .12	.10 – .12
Hydroxide(c'stic potash) dr., lb	.07 – .07½	.07 – .07½	.07 – .07½
Muriate, 80% bags, unit	.53½–......	.53½–......	.53½–......
Nitrate, bbl., lb	.05½– .06	.05½– .06	.05½– .06
Permanganate, drums, lb	.18½– .19	.18½– .19	.18½– .19
Prussiate, yellow, casks, lb	.15 – .16	.15 – .16	.15 – .16
Sal ammoniac, white, casks, lb	.0515 .06	.0515 .06	.05 – .05½
Salsoda, bbl., cwt	1.00 – 1.05	1.00 – 1.05	1.00 – 1.05
Salt cake, bulk, ton	17.00 –......	17.00 –......	23.00 –......
Soda ash, light, 58%, bags, contract, cwt	1.05 –......	1.05 –......	1.05 –......
Dense, bags, cwt	1.10 –......	1.10 –......	1.10 –......
Soda, caustic, 76%, solid, drums, cwt	2.30 – 3.00	2.30 – 3.00	2.30 – 3.00
Acetate, works, bbl., lb	.04 – .05	.04 – .05	.04 – .05
Bicarbonate, bbl., cwt	1.70 – 2.00	1.70 – 2.00	1.70 – 2.00
Bichromate, casks, lb	.06¾– .07	.06¾– .07	.06¾– .07
Bisulphate, bulk, ton	16.00 –17.00	16.00 –17.00	15.00 –16.00
Bisulphite, bbl., lb	.03 – .04	.03 – .04	.03½– .04
Chlorate, kegs, lb	.06¼– .06½	.06¼– .06½	.06¼– .06½
Cyanide, cases, dom., lb	.14 – .15	.14 – .15	.14 – .15
Fluoride, bbl., lb	.07 – .08	.07 – .08	.07½– .08
Hyposulphite, bbl., cwt	2.40 – 2.50	2.40 – 2.50	2.40 – 2.50
Metasilicate, bbl., cwt	2.35 – 2.40	2.35 – 2.40	2.20 – 3.20
Nitrate, bulk, cwt	1.45 –......	1.45 –......	1.45 –......
Nitrate, casks, lb	.06¾– .07	.06¾– .07	.06¾– .07
Phosphate, tribasic, bags, lb	2.35 –......	2.25 –......	2.10 –......
Prussiate, yel. drums, lb	.10½– .11	.10½– .11	.09½– .10
Silicate (40° dr.) wks., cwt	.80 – .85	.80 – .85	.80 – .85
Sulphide, fused, 60–62%, dr. lb	.02¾– .03½	.02¾– .03	.02¾– .03
Sulphite, crys, bbl., lb	.02¼– .02¼	.02¼– .02½	.02¼– .02½
Sulphur, crude at mine, bulk, ton	16.00 –......	16.00 –......	16.00 –......
Chloride, dr., lb	.03 – .04	.03 – .04	.03 – .04
Dioxide, cyl., lb	.07 – .08	.07 – .08	.07 – .07½
Flour, bag, cwt	1.60 – 3.00	1.60 – 3.00	1.60 – 3.00
Tin Oxide, bbl., lb	.54 –......	.54 –......	.52 –......
Crystals, bbl., lb	.38 –......	.38 –......	.36 –......
Zinc, chloride, gran, bbl., lb	.05 – .06	.05 – .06	.05 – .06
Carbonate, bbl., lb	.14 – .15	.14 – .15	.14 – .15
Cyanide, dr., lb	.33 – .35	.33 – .35	.33 – .35
Dust, bbl., lb	.09¼–......	.09¼–......	.07¾–......
Zinc oxide, lead free, bag, lb	.06½–......	.06½–......	.06½–......
5% lead sulphate, bags, lb	.06½–......	.06½–......	.06¼–......
Sulphate, bbl., cwt	3.15 – 3.25	3.15 – 3.25	2.75 – 3.00

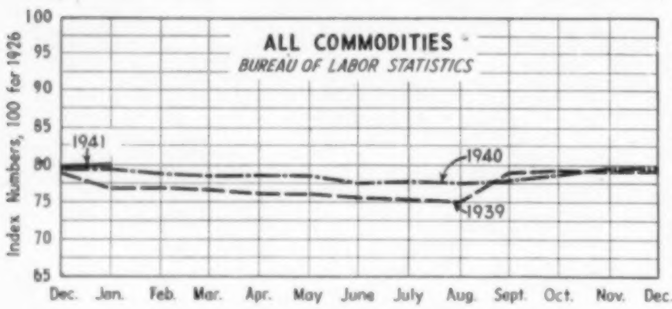
OILS AND FATS

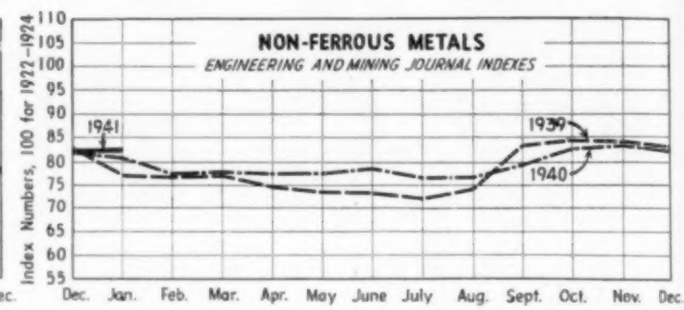
	Current Price	Last Month	Last Year
Castor oil, 3 bbl., lb	$0.10¾–$0.11	$0.10¾–$0.11	$0.11½–$0.12
Chinawood oil, bbl., lb	.27¼–......	.27¼–......	.27 –......
Coconut oil, Ceylon, tank, N. Y., lb	.03¾–......	.03¾–......	.03¼–......
Corn oil crude, tanks (f.o.b. mill), lb	.07 –......	.06¾–......	.06 –......
Cottonseed oil, crude (f.o.b. mill), tanks, lb	.05½–......	.05¾–......	.06 –......
Linseed oil, raw car lots, bbl., lb	.097–......	.095–......	.103–......
Palm, casks, lb	.0415–......	.04½–......	.05¾–......
Peanut oil, crude, tanks (mill), lb	.05½–......	.05¾–......	.06¾–......
Rapeseed oil, refined, bbl., gal	.95 –......	1.00 –......	1.00 –......
Soya bean, tank, lb	.05¾–......	.05½–......	.05¼–......
Sulphur (olive foots), bbl., lb	.10 –......	.10 –......	.08½–......
Cod, Newfoundland, bbl., gal	nom......	nom......	nom......
Menhaden, light pressed, bbl., lb	.09 –......	.078–......	.075–......
Crude, tanks (f.o.b. factory), gal	.35 –......	.30 –......	.36 –......
Grease, yellow, loose, lb	.04¾–......	.04½–......	.05 –......
Oleo stearine, lb	.06½–......	.06½–......	.06½–......
Oleo oil, No. 1	.07¾–......	.06¾–......	.07½–......
Red oil, distilled, d.p. bbl., lb	.06¾–......	.06¼–......	.09 –......
Tallow extra, loose, lb	.05 –......	.05 –......	.05½–......

Chem. & Met.'s Weighted Price Indexes









Coal-Tar Products

	Current Price	Last Month	Last Year
Alpha-napthol, crude bbl., lb.	$0.52 –$0.55	$0.52– $0.55	$0.52 –$0.55
Alpha-naphthylamine, bbl., lb.	.32 – .34	.32 – .34	.32 – .34
Aniline oil, drums, extra, lb.	.15 – .16	.15 – .16	.15 – .16
Aniline, salts, bbl., lb	.22 – .24	.22 – .24	.22 – .24
Benzaldehyde, U.S.P., dr., lb	.85 – .95	.85 – .95	.85 – .95
Benzidine base, bbl., lb	.70 – .75	.70 – .75	.70 – .75
Benzoic acid, U.S.P., kgs., lb.	.54 – .56	.54 – .56	.54 – .56
Benzyl chloride, tech., dr., lb	.23 – .25	.23 – .25	.23 – .25
Benzol, 90%, tanks, works, gal.	.14 –......	.15 – .18	.16 – .18
Beta-napthol, tech., drums, lb.	.23 – .24	.23 – .24	.23 – .24
Cresol, U.S.P., dr., lb	.09½– .10	.09½– .10	.09½– .10
Cresylic acid, dr., wks., gal.	.58 – .60	.58 – .60	.58 – .60
Diethylaniline, dr., lb	.40 – .45	.40 – .45	.40 – .45
Dinitrophenol, bbl., lb	.23 – .25	.23 – .25	.23 – .25
Dinitrotoluol, bbl., lb	.15½– .16	.15½– .16	.15 – .16
Dip oil, 15%, dr., gal	.23 – .25	.23 – .25	.23 – .25
Diphenylamine, bbl., lb	.25 – .27	.25 – .27	.32 – .36
H-acid, bbl., lb	.45 – .50	.45 – .55	.50 – .55
Naphthalene, flake, bbl., lb.	.07 – .07½	.07 – .07½	.05¾– .06
Nitrobenzene, dr., lb.	.08 – .09	.08 – .09	.08 – .09
Para-nitraniline, bbl., lb.	.47 – .49	.47 – .49	.47 – .49
Phenol, U.S.P., drums, lb.	.12 –......	.12 –......	.13 –......
Picric acid, bbl., lb	.35 – .40	.35 – .40	.35 – .40
Pyridine, dr., gal	1.70 – 1.80	1.70 – 1.80	1.55 – 1.60
Resorcinol, tech., kegs, lb.	.75 – .80	.75 – .80	.75 – .80
Salicylic acid, tech., bbl., lb.	.33 – .40	.33 – .40	.33 – .40
Solvent naptha, w.w., tanks, gal.	.27 –......	.27 –......	.26 –......
Tolidine, bbl., lb	.86 – .88	.86 – .88	.86 – .88
Toluol, drums, works, gal.	.30 –......	.30 –......	.27 –......
Xylol, com, tanks, gal.	.26 –......	.27 –......	.26 –......

Miscellaneous

	Current Price	Last Month	Last Year
Barytes, grd., white, bbl., ton	$22.00–$25.00	$22.00–$25.00	$22.00–$25.00
Casein, tech, bbl., lb.	.12½– .14	.13 – .14	.13 – .17
China clay, dom., f.o.b. mine, ton.	8.00 –20.00	8.00 –20.00	8.00 –20.00
Dry colors			
Carbon gas, black (wks.), lb	.028– .30	.028– .30	.02¾– .30
Prussian blue, bbl., lb.	.36 – .37	.36 – .37	.36 – .37
Ultramarine blue, bbl., lb.	.11 – .26	.11 – .26	.10 – .26
Chrome green, bbl., lb	.21½– .30	.21½– .30	.21 – .27
Carmine, red, tins, lb.	4.85 – 5.00	4.85 – 5.00	4.85 – 5.00
Para toner, lb.	.75 – .80	.75 – .80	.75 – .80
Vermilion, English, bbl., lb	3.12 – 3.20	3.12 – 3.20	2.70 – 2.90
Chrome yellow, C.P., bbl., lb.	.14½– .15½	.14½– .15½	.14½– .15½
Feldspar, No. 1 (f.o.b. N.C.), ton.	6.50 – 7.50	6.50 – 7.50	6.50 – 7.50
Graphite, Ceylon, lump, bbl., lb.	.06 – .06½	.06 – .06½	.06 – .06½
Gum copal Congo, bags, lb	.08 – .30	.08 – .30	.06 – .30
Manila, bags, lb.	.09 – .15	.09 – .14	.09 – .14
Damar, Batavia, cases, lb	.10 – .22	.10 – .20	.08 – .24
Kauri, cases, lb	.18 – .60	.18 – .60	.18½– .60
Kieselguhr (f.o.b. N.Y.), ton.	50.00 –55.00	50.00 –55.00	50.00 –55.00
Magnesite, calc, ton	50.00 –......	50.00 –......	50.00 –......
Pumice stone, lump. bbl., lb	.05 – .07	.05 – .08	.05 – .07
Imported, casks, lb	.03 – .04	.03 – .04	.03 – .04
Rosin, H., 100 lb.	2.33 –......	2.52 –......	.... –......
Turpentine, gal	.45½–......	.47 –......	.41 –......
Shellac, orange, fine, bags, lb.	.26 –......	.27 –......	.28 –......
Bleached, bonedry, bags, lb.	.27 –......	.27 –......	.25 –......
T. N. Bags, lb	.16 –......	.16 –......	.19 –......
Soapstone (f.o.b. Vt.), bags, ton.	10.00 –12.00	10.00 –12.00	10.00 –12.00
Talc. 200 mesh (f.o.b. Vt.), ton.	8.00 – 8.50	8.00 – 8.50	8.00 – 8.50
300 mesh (f.o.b. Ga.), ton	7.50 –10.00	7.50 –10.00	7.50 –11.00
225 mesh (f.o.b. N.Y.), ton	13.75 –......	13.75 –......	13.75 –......

Industrial Notes

THE OKONITE Co., Passaic, N. J., has opened a branch office in the Comer Bldg., Birmingham, Ala., with Dewey A. White in charge. The St. Louis office has been moved to the Shell Bldg. Robert E. Sontag is in charge.

THE LUDLOW VALVE MFG. Co., Troy, N. Y., has elected Alfred W. Thompson president, treasurer, and general manager. Robert Bischoff has been appointed sales manager.

GENERAL ELECTRIC Co., Schenectady, N. Y., has moved J. J. Curtin from sales promotion work in the motor division to the wire and cable division at Fort Wayne, Ind. O. F. Vea succeeds Mr. Curtin at Schenectady.

THE UNITED STATES STONEWARE Co., Akron, Ohio, has acquired the business and properties of the Federal Clay Product Co. at Mineral City and has incorporated it as the Federal Refractories Corp.

THE FALK CORP., Milwaukee, has advanced Harold F. Falk to the position of general superintendent.

AMERICAN CHAIN & CABLE Co., York, Pa., has appointed George B. Kutz sales manager for the southeastern territory of the Wright Mfg. division.

THE COOPER ALLOY FOUNDRY Co., Elizabeth, N. J., has bought the property of the Breen Iron Works at Hillside and will use it in its manufacturing operations.

LA BOUR Co., Elkhart, Ind., has transferred N. A. Pedersen from sales representative in the New York area to the plant. M. A. Rumely succeeds Mr. Pedersen as New York sales representative with headquarters in Newark.

TUBE-TURNS, INC., Louisville, has appointed John C. Chaffe district manager of the Philadelphia office which has been moved to the Broad Street Station Bldg.

SARCO Co., INC., 183 Madison Ave., New York, will move its offices on March 1 to 475 Fifth Ave.

BARADA & PAGE, INC., Kansas City, Mo., has purchased the business and properties of the Russel-Hale Chemical Co., at Houston, Tex., and at New Orleans, La.

CHARLES PFIZER & Co., New York, has purchased property alongside its plant in Brooklyn and will build a laboratory and office building at a cost of approximately $750,000.

Chem & Met New CONSTRUCTION

	Current Projects		Cumulative 1941	
	Proposed Work	Contracts	Proposed Work	Contracts
New England	....	$91,000	....	$386,000
Middle Atlantic	$2,000,000	765,000	$2,040,000	2,180,000
South	80,000	....	6,120,000	80,000
Middle West	150,000	240,000	225,000	1,205,000
West of Mississippi	1,400,000	522,000	2,145,000	3,734,000
Far West	....	12,442,000	40,000	542,000
Canada	280,000	170,000	420,000	170,000
Total	$3,910,000	$14,230,000	$10,990,000	$8,297,000

PROPOSED WORK

Fla., Wewahitchka—St. Joe Paper Co., Wewahitchka, plans to construct additional plant buildings. Estimated cost will exceed $40,000.

Ind., East Chicago—Sinclair Refining Co., 2540 West Cermak Rd., Chicago, Ill., will soon receive bids for a 1 story, 85x100 ft. and 1 story, 90x250 ft. oil storage building here. Estimated cost $100,000.

Ind., Noblesville—Schacht Rubber Co., John Mason, Mgr., will soon receive bids for a 1 story, 80x304 ft. factory and warehouse addition here. Estimated cost $50,000.

Mo., Kansas City—W. S. Dickey Clay Manufacturing Co., New York Life Bldg., is having plans prepared by Alfred Benberg, Archt. 1, New York Life Bldg., for the construction of a clay products plant here. Estimated cost $400,000.

N. Y., Buffalo—Donner-Hanna Coke Corp., Albany and Mystic Sts., plans to construct additions to its coke plant. Estimated cost including equipment $2,000,000.

N. C., Fayetteville—Southern Cotton Oil Co., O. L. Stubbs, Mgr., plans to rebuild the linter building of its cotton oil plant recently destroyed by fire. Estimated cost $40,000.

Tex., East Bernard—O. S. Knisely, c/o H. C. Cockburn, East Bernard, contemplates the construction of a recycling plant here. Estimated cost $350,000.

Tex., Tuleta—Anderson Prichard Oil Corp., and Mills Bennett Production Co. and associates, Beeville and Corpus Christi, Tex., plan to construct a recycling plant in the West Tuleta oil field. Estimated cost $400,000.

Wyo., Cheyenne—Frontier Refining Co., plans to construct a cracking plant here and install new machinery. Estimated cost $250,000.

Ont., Toronto—Seiberling Rubber Co., of Canada, Ltd., 90 Patou Rd., is having plans prepared by James, Proctor & Redfern, Engrs., Excelsior Life Bldg., for the construction of a 2 story, 100x100 ft. warehouse. Bids will soon be received by the engineers. Estimated cost $75,000.

Ont., Windsor—Wall Chemicals Canadian Corp., Ltd., c/o Liquid Carbonic Corp., 3100 South Kedzie Ave., Chicago, Ill., plans to construct an addition to its plant here. Estimated cost $50,000.

Que., Beloeil—Canadian Industries, Ltd., 1135 Beaver Hall Hill, Montreal, plans to construct an addition to its powder plant here. Estimated cost $40,000.

Que., Montreal—Wall Chemicals, Ltd., 5725 St. Denis St., plans to construct a plant for the manufacture of oxygen and acetylene gases on Hadley St. T. Pringle & Son, Ltd., 485 McGill St., Montreal, Engr. Estimated cost $75,000.

Sask., Regina—Sybouts Sodium Sulphate Co., Ltd., plans to construct a plant here. Estimated cost $40,000.

CONTRACTS AWARDED

Ala., Childersburg—U. S. War Dept., Wash., D. C., has awarded the contract for the construction and operation of a smokeless powder and bag operating plant here to E. I. du Pont de Nemours & Co., Wilmington, Del. Estimated cost $35,000,000.

Calif., Permanente—Permanente Corp., San Jose, Calif., H. J. Kaiser, Pres., Latham Sq. Bldg., Oakland, will construct a magnesium reduction plant to have a capacity of 12,000 tons per year adjacent to its cement plant. Work will be done by day labor and subcontracts. Estimated cost $12,000,000.

Calif., Sacramento—Zellerbach Paper Co., 534 Battery St., has awarded the contract for additions to its warehouse to C. Vanina & Son, 2022 M St., Sacramento, at $42,024.

Conn., Shelton—Mullite Refractories Co., Canal St., has awarded the contract for a plant to Smith Construction Co., 101 Water St., Derby, Conn. Estimated cost $50,000.

Ill., Chicago—Petrolagar Laboratories, 8100 McCormick Blvd., have awarded the contract for a 1 story addition to their pharmaceutical plant to J. E. Anderson & Son, 3659 Belle Plaine Ave., Chicago. Estimated cost $40,000.

Ill., Monsanto—(br. East St. Louis) U. S. War Dept., Wash., D. C., has awarded the contract for a plant for the manufacture of gas warfare defense chemicals to Monsanto Chemical Co., Monsanto. Estimated cost $3,352,000.

Ia., Bettendorf—Quaker Petroleum Co., Bettendorf, will construct a 7,000,000 gal. capacity bulk oil plant complete with tanks, piping, etc. Work will be done with local labor. Estimated cost including equipment $40,000.

Mass., Westfield—Stevens Paper Mills, Inc., 71 Mill St., has awarded the contract for a 2 story, 52x108 ft. addition to its mill to R. F. Jones Co., 15 Lewis St., Hartford, Conn., at $41,300.

N. J., New Brunswick—Wallace Laboratories, 300 Communipaw Ave., Jersey City, N. J., have awarded the contract for a 1 and 2 story, 150x370 ft. manufacturing plant to Matthews Construction Co., 296 Alexander Ave., Princeton. Estimated cost $500,000.

N. J., Parlin—New Jersey Powder Co., c/o Hercules Powder Co., 9th and Market Sts., Wilmington, Del., has awarded the contract for a 1 story, 90x100 ft. barrel house and storage building at its plant here to Wigton-Abbott Corp., 1225 South Ave., Plainfield.

N. Y., Niagara Falls—Union Carbide Co., 137 47th St., has awarded the contract for a plant to Walter S. Johnson Building Co., 2532 Hyde Park Blvd. Estimated cost $50,000.

N. Y., Niagara Falls—U. S. War Dept., Wash., D. C., has awarded the contract for a plant for the manufacture of gas mask charcoal and other chemicals to E. I. du Pont de Nemours & Co., Wilmington, Del. Estimated cost $5,000,000.

N. Y., Tonawanda—Frontier Fuel Oil Corp., Ellicott Sq. Bldg., Buffalo, N. Y., has awarded the contract for a refinery to Alcorn Combustion Co., Schaff Bldg., Philadelphia, Pa. Estimated cost $75,000.

O., Akron—Goodyear Tire & Rubber Co., 1144 East Market St., has awarded the contract for a 2 story, 100x150 ft. synthetic rubber factory to Indiana Engineering & Construction Co., 109 North Union St., Akron. Estimated cost $100,000.

O., St. Marys—St. Marys Manufacturing Co., subsidiary of Goodyear Tire & Rubber Co., has awarded the contract for two additions to its plant here to Herbert U. Tuttle Construction Co., Lima, O. Estimated cost $250,000.

Pa., Port Allegany—Pittsburgh Corning Corp., Port Allegany, has awarded the contract for a plant to H. K. Ferguson Co., Hanna Bldg., Cleveland, O. Estimated cost $50,000.

Pa., Westline—Union Charcoal Co., D. M. Hancock, Pres., plans to rebuild its acetic acid plant and other buildings. Work will be done by separate contracts. Estimated cost $50,000.

Tex., Houston—Petroleum Rectifying Co., Petroleum Bldg., Houston, Tex., has awarded the contract for an oil rectifying plant and warehouse to Schneider Construction Co., 4317 Roseland St., Houston. Estimated cost $42,000.

Tex., Silsbee—Republic Production Co., Silsbee and c/o Republic Refining Co., Texas City, has awarded the contract for the second unit of its crude oil stabilization plant at St. Joes Lake near here to Frick-Reid Supply Corp., 108 North Trenton St., Tulsa, Okla. Estimated cost $90,000.

Wash., Seattle—Richfield Oil Corp., 555 South Flowers St., Los Angeles, Calif., has awarded the contract for warehouse, pump house, foamite house, loading racks, etc., in connection with marine terminal here to Puget Sound Bridge & Dredging Co., 2929 16th Ave., S. W., Seattle. Estimated cost $400,000.

Wis., Racine—S. C. Johnson & Son, Inc., Racine, have awarded the contract for a new "Glo-Coat" factory to Johnson & Henrickson, Racine. Estimated cost $200,000.

Ont., London—Yocum Faust Chemical Co., St. George St., has awarded the contract for rebuilding part of factory destroyed by fire to Central Construction Co., 169½ Dundas St. Estimated cost $50,000.

Ont., Port Hope—Cosmos Chemical Co., Ltd., 14 Carvan St., has awarded the contract for an addition to its plant to B. Bennington & Son, 21 Ontario St.

Que., Montreal—Dominion Oxygen Co., Ltd., 7 Bourgeois St., has awarded the contract for an addition to its plant to Foundation Co. of Quebec, Ltd., 1538 Sherbrooke St., Montreal.

Que., Outremont—McArthur-Irwin, Ltd., 11 Bates Rd., has awarded the contract for an addition to its paint manufacturing plant to Corinthian Construction Co., Ltd., 5726 Sherbrooke St., Montreal. Estimated cost $40,000.